THE OCEAN TELEGRAPH CABLE

BY

W. Rowett

1865.

THE OCEAN TELEGRAPH CABLE;

Its Construction, the Regulation of its Specific Gravity, and

SUBMERSION EXPLAINED,

(WITH MAP AND ILLUSTRATIONS)

BY

W. William ROWETT.

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PREFACE.

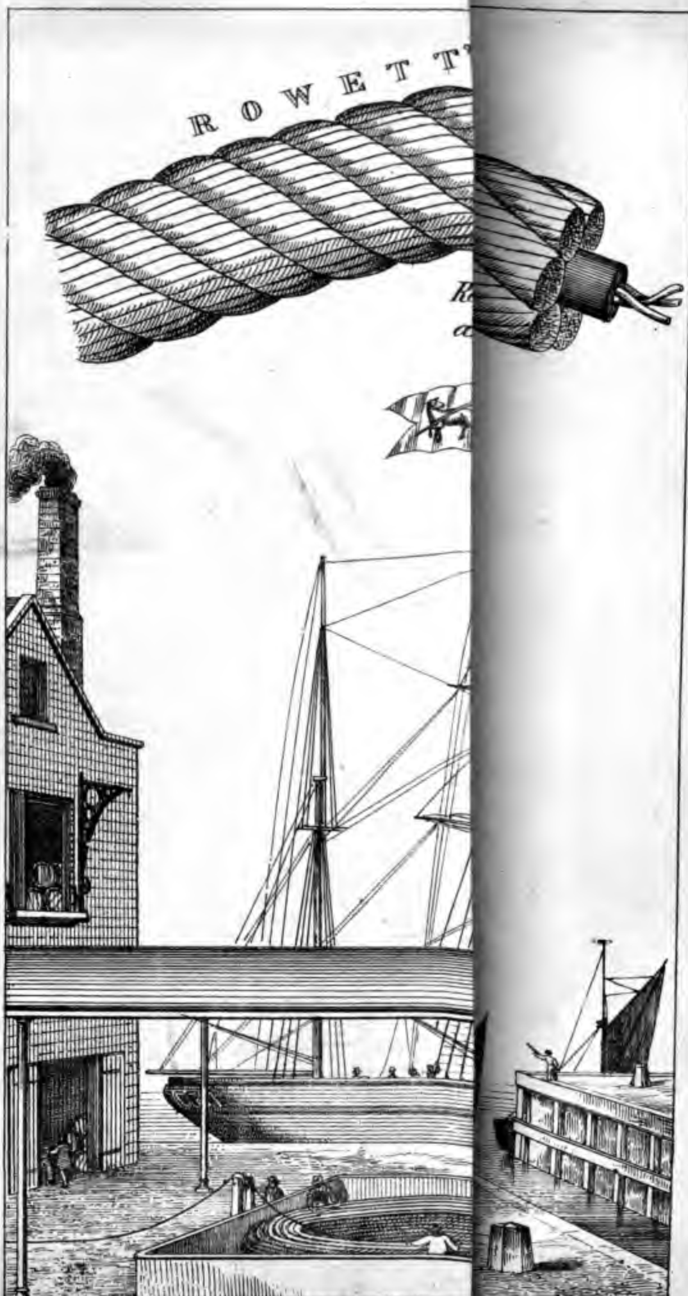
The following pages are intended as a contribution to the development of the science of making and laying Telegraph Cables across deep seas, and are respectfully dedicated to the public, as a tribute of sincere regard for the great and benevolent work of the Royal National Life Boat Institution.

Whatever profits may arise from the sale of the book will be cheerfully devoted to the encouragement of the brave fellows who are ever ready to man its boats.

THE AUTHOR.

ERRATUM.

Page 31, third line from bottom, for *stitching* read *stretching*.



The Ship taking on board the Cable *ceived on board.*

MAP SHOWING THE INTENDED

DISTANCES.

Brest to Cape Finisterre,

Cape Finisterre to Terceira

Terceira to Flores

Flores to the Bank of Newfou

Bank of Newfoundland to St.

OCEAN TELEGRAPHY.

THE lowest expectations cannot be satisfied with what has been done in the cause of Ocean Telegraphy; it may be for want of knowing the defects or idleness in supplying them. As, therefore, some practical explanations appear to be wanting for the perusal of common readers, and as I may claim to myself some years' acquaintance with the practical philosophy of this complex, but important subject, I venture to offer to the public a chapter or two, which at this juncture may be interesting, and will I trust contribute in some degree to lead the public mind into useful and timely reflection before vast sums are again irrecoverably consigned to the bed of the Ocean in the form of Telegraph Cables, which, by their construction, violate the golden rules of science, and thereby cause delay as well as incalculable damage to the economical solution of the great problem itself.

The following paper was long ago prepared to be read before the Royal Geographical Society, partly as an answer to the Blue Book Report of 1861, on Ocean Telegraphy—but having been called away to the continent, my opportunity of reading it passed—but now that the public mind seems to be again drawn away into important practical errors in this matter, it is the more desirable I should put into the form of

a pamphlet, the delayed address along with sundry other papers, also long since written, and which would not now have been offered to public notice if the subject of Ocean Telegraphy had been fully and fairly ventilated by others.

ANSWER TO THE BLUE BOOK REPORT ON THE CONSTRUCTION OF SUB-MARINE TELEGRAPH CABLES.

Sub-marine Telegraphy may be considered under three departments, namely: the electrical, mechanical, and nautical. It may, therefore, be asked what can the Geographical Society have to do with either of them? for by their terms they seem to be as wide as the poles apart. And so they are, if we leave out the Geographical department of what is nautical, and overlook the bed of the Ocean, with its dark recesses and boundless treasures, that unhappily have been so constantly drawn there since the day of creation to the present, which are entitled to a passing geological glance, a microscopic peep into the organizations brought up by the sounding line, or to inspire a passing wonder, whether in such vast depths the *supposed* superincumbent weight of water will admit of any use, whatever, being made of the ground on which such mighty waters rest.

But if it should be made clear that one, at least, and that one the most important, use can be made of the bed of the Ocean—that neither its most boisterous surface, its most extreme depth, its most rugged and

precipitate undulations, or the utter darkness in which it is shrouded, present any insuperable difficulty in laying the electric wire from shore to shore, however distant from each other—we may then fairly conclude that geographical inquiry is of the utmost importance to, and intimately connected with, Ocean Telegraphy; and I submit your society treads one of the most important paths of duty when this subject is discussed by it.

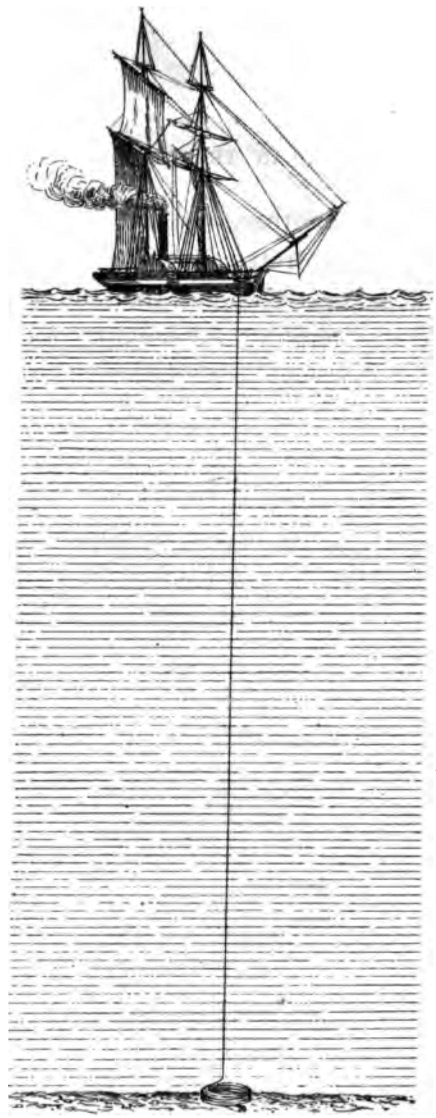
It is not, however, my purpose to lay before you debatable points of electrical theories, nor even to offer any remarks upon the numberless methods devised for insulating the electric conductor; these we may presume are far advanced towards perfection, and only wait the geographical and nautical solution of the problem of Ocean Telegraphy to give full scope to their manufacture.

Neither is it my purpose to discuss at large the notion of superincumbent, or column weight of water at increased depths; that part of the problem it was my privilege to publish several years ago, and the reasoning employed has not since been controverted, but in fact confirmed by the practical tests officially reported by Captain Dayman, in his government survey of the Atlantic. His lead, sent down in a depth of over 2,000 fathoms, conclusively proves the fallacy of the received notion on this point. The lead having reached the bottom, the line *by its own weight alone* continued to run down directly upon the lead, for in hauling it up it was found to be fouled by one

fold overlapping another, and in a coil of 200 fathoms in the manner illustrated by Captain Dayman in his report; and it must be noted that the whole operation of sinking and hauling up only occupied an hour or two—in fact the sinking, as reported by that excellent officer, only occupied about 56 minutes.* Nothing could more clearly prove there was no increased column pressure, and if there is no vertical weight of water, it is also logically clear there can be no lateral pressure; but though it has been considered a danger, and most prejudicially magnified, it is in fact a simple matter of specific gravity.

The great Ocean basin holding the vast waters in their place, relieved of their superincumbent weight on the bottom, by the centrifugal motion of the earth, and the element being incompressible in its nature, renders it simply impossible for it to press upon any denser body submerged, more than the amount of its simple displacement; and no practical proof could be more complete, or a voice from the depths of the Ocean more clear and unmistakable than the story told by the thirteen star fish, which were brought up by Captain Sir L. McClintock's sounding line from a depth of 1,260 fathoms in 1860; and the beautiful bright coloured crustacean taken from 1,400 fathoms by the Swedish expedition under Mr. Torell,—these proclaimed a truth to the most unwilling believers, that no pressure existed on the earth from whence they came to injure the most delicately constructed telegraph cable, for so lightly did the element

* See Plate 1.



CAPTN DAYMAN'S Report, (Page 7),
Published by order of the LORDS COMMISSIONERS of the ADMIRALTY,
H.M. Ship "CYCLOPS" Sounding.
July 16th, 1857.

"The Sea being too high for the employment of smaller lines I sounded with the tapered "Whale line, and a Sinker of 96 lbs weight.

"The depth thus found was 2,176 fathoms, but 2400 fathoms of line had been paid "out to make sure of detaching the weight, and - to our surprise, - the 200 fathoms next "to the Sinker came up to the surface in one tangled Coil - as shown in Plate 3."

rest upon them in their deep domain, that they were able to travel over it and cull the supplies which nature required them to do, and though they were beyond the reach of the solar rays, they had been providentially provided with a phosphoric supply of light, by which to see the food that had been produced by the sun, and showered down upon them, as manna once descended from heaven for the necessities of man.

Then with reference to the geographical character and construction of the bed of the Ocean, I beg to offer some remarks before passing on to speak of the cable that may, some early day, rest safely on it, secure from all the real, as well as the host of imaginary dangers that have been conjured up to the damage of the cause, and which prejudice, fed by interested motives, will always inflict, even on what is more plainly demonstrated to our senses.

It is natural to conclude that when the earth received its form from the hand of the Almighty Creator, the bed of the Ocean partook of the same irregularities that present themselves over the land that is not submerged—and it is possible that those uneven undulations still remain. But we have some reason to conclude that their condition has, during the vast period (whatever that may be), since the creation, been very much changed.

The dry land, which is subject to the sweeping effects of the atmospheric element, presents perhaps the same sharp outlines, whilst the bed of the deep Ocean (so far as we have reason to conclude), is perfectly tranquil,

and if we may judge from the countless communications with the dark regions of the Ocean bed, by means of the sounding line—especially in the more southern latitudes—the Ocean's surface has been a most fertile field, and its bottom a quiet and safe depository of its vast productions.

"Ooze," is the invariable description of the meagre amount of matter from time to time brought from the deep sea bed; and this microscopically examined is found to be the remains of a minute shell, which leaves no doubt that during its brief lifetime it inhabited the surface of the sea, generated into life from decomposed matter on the sea, exposed to the rays of the sun (especially during calms, when the surface becomes literally alive, and often emits a foul odour), and those insects, generated from the filth which immediately surrounds the ship becalmed, are as viscious, and no doubt of the same species, as those generated in the still waters of a Mediterranean port, which receive the sewage of the city, and in like manner they attack the exposed wood of a ship's side and effect the same kind of destruction, even on the equator.

Fatty matter from the whale and countless other fish that inhabit the surface of the deep sea, as well as birds, and marine weeds, that form in warm and quiet water, but soon decompose, and take other forms of life, and finally a shelly substance is assumed, which the first ripple of the sea kills, and being heavier than water sinks of course to the bottom, and their remains we call "ooze," the particles of

which are sometimes so extremely minute, that to the naked eye it may seem to be mud or clay.

But when we reflect for a moment that this process has been in operation since the morning of the creation, we can with considerable amount of reason conclude that the Ocean bed, however sharp and pointed were its undulations at the beginning, may now be covered with a vast depth of "ooze," and present a cushion on which electric cables would lay as on a feather bed, or rather on the bed which a wise Providence has in the appointed time prepared for its reception, that the nations of the earth might be blessed with closer ties of intercourse and brotherhood, thus another step in his light is developed to man—and geographical knowledge made an instrument through your noble institution.

Again, let me ask your attention for a moment to another geographical point in our case, before we advance to the main subject of our inquiry.

The problem of Ocean Telegraphy is not essentially confined to deep water, but at least includes the necessity of landing on the shore, and it is true, cables of delicate construction could not bear the wear and tear of the surge to which it must be exposed on the coast—the tidal wave and other abrading effects imperativly demand an iron wire cable, for such purposes, we are told. But even this we deny to be absolutely necessary, because we can surely avoid the alternative of landing our cable on rocks, and it must be admitted, from low water mark spring tides, we

can dig some small desired depth, and bury any light and delicate cable in the beach below the effects of the heaviest sea; and by means of a diving bell, properly constructed, we could with great facility lay it under the ground to any desired distance from the shore, where abrasion would be entirely obviated, and even out of the way of anchors that hook them when exposed on the surface.

If the heavy iron shore ends had been thus managed much of the disastrous losses sustained by several enterprising Telegraph Companies would have been avoided; and in this manner a cable preserved in the way I may presently describe, might long ago have been laid across the Mersey, perfectly clear of the largest anchors that occasionally scrape two or three feet of the surface of the bed of that river.

I presume I may now, without violating the rules of your institution, advance to the consideration of the means of laying telegraph cables across deep Oceans, which are so clearly suggested by Geographical as well as other imperial considerations.

After the series of practical letters that were some months ago published on the several branches of science involved in the great problem under discussion, it may serve the cause best if I am permitted to say a few words on the evidence and report so elaborately drawn out and published in June, 1861, by the Committee appointed by the Board of Trade, "to inquire into the construction of submarine Telegraph Cables."

We have here to deal with a public document, comprising 519 folio pages, which has occupied some of the most talented men for nearly two years, supposed to contain a clear development of the great question of Ocean Telegraphy.

The subject is a mighty one, and we deeply regret that all has not been said that might have been said upon it; nor was its complete solution likely to be attained, when one most important provision for the inquiry was left out.

The subject, we have said, consists of three distinct departments. First of all, the electrical branch which has been brought to so great perfection by Messrs. Wheatstone, Thompson, and others, who deserve well of their country. They show that a continuous wire conductor secured from contact with water, and electrically insulated, will transmit signs or words to any indefinite distance; and the Atlantic Cable has proved that even in the deep Ocean more than 2000 miles of cable, and that in a very damaged condition, conveyed messages for a time clearly. The position of this department of the inquiry then, whatever room there might still be for improvement, may be considered as highly satisfactory.

Secondly, the means of protecting and insulating the wire conductor. If this branch of the science is to be confined to eminent electricians and engineers, there has been ample talent brought to bear on it also.

The third branch of the science is most essential to

make the others of value. Neither the perfect conductor, nor the perfect insulation, can be of any use unless there be a means of laying them safely in deep water. This involves considerations as far from the skill of a landsman, as the electrical and engineering science can be from that of the practical seaman. No doubt, to be eminent in either branch vast labour and skill must be applied; but we may safely conclude that practical seamanship in all its branches is not only the most arduous but the most difficult—few men of literary accomplishments will undertake the task; for want of this element perhaps much of their other valuable experience is lost. Still there are many whose labours might have been secured to the Committee; but strange to say, it seems not to have been considered necessary that any seaman should share the responsibilities involved in this momentous inquiry, though the question at issue was essentially a nautical one.

It is true nautical witnesses have been examined, and proved no doubt of much value, but how much more practical benefit would have resulted if questions had been put by a responsible nautical member of the Committee?

One can imagine what would be said if a Committee of Seamen were to be appointed to sit in judgment upon some great question of electrical or engineering science: the press would justly thunder over their heads, and declare the report even of the honest tar valueless, however talented.

This brings us to an evident defect in the formation of the Committee in the very outset of the inquiry.

Mr. Gisborne is the first witness examined, and as he was only gently examined by his brothers of the same profession, for the sake of truth, science, and especially the public interest, it may not be amiss to examine this gentleman's evidence by the clear and practical light a seaman can throw upon it.

Mr. Lionel Gisborne said, "that he is a Civil "Engineer, but never personally superintended the "laying down of more than one cable; that he was "then Engineer to the Red Sea and Indian Telegraph "Company, and to the Falmouth and Gibraltar Tele- "graph, on account of the Government. He specified "the class of cables to be laid down, and that he "understood the manufacture of cables and the prin- "ciples of them."

Page 2, question 24.—"Did the vessel pitch at "all?"—"Enough to make me sea-sick; we had no "rough weather."

Thus, even in fine weather, the Engineer in charge of and responsible for the paying out of the cable is sea-sick. Most of us know the prostrating effects of sea-sickness. This, however, is only one of the many such dangers to which the Shareholders' capital is subject.

Page 3, No. 37.—(Chairman): "Of the other "cables with which you have been connected, did any "fail?"—"One cable failed three times, the cable "from Candia to Alexandria."

No. 38.—"What were the causes of the failure?"

" An iron covered cable had been designed, some-
" thing like the Corfu and Malta cable, * * * but
" Messrs. Newall, who had undertaken to lay this
" cable at their own cost, as a matter of economy tried
" a hemp covered cable. Here is a piece of it (*pro-*
" *ducing the same*) that was picked up in 400 fathoms
" of water, and this hempen cable has to go down in
" depths 1,600 and 1,800 fathoms, and as much as
" 1,900 fathoms; they paid out 129 miles of this cable,
" and they covered 128 miles of ground, and it was
" blowing extremely hard, and they hung on to that
" cable for 36 hours, blowing so hard that boat
" communication between the man-of-war and them-
" selves was impossible. At the end of that time a
" fault was found to exist—a fault as to insulation;
" they tried to pick up the cable, and it broke, and
" they were then, I think, in 1500 fathoms."

Thus it is admitted that a hemp cable was not only laid with safety in this extreme depth in stormy weather, but that for 36 hours the ship hung on to it; and that only one mile of slack had been paid out over a distance of 128 miles, and then after all this hard usage a fault was found to exist. Now certainly no iron cable was ever known to do its work so well; and yet, after all, this witness condemns hemp covered cables though this practical test proved the cable so good, in the storm as well as in deep water.

He goes on to say—" Since that cable failed, expe-
" riments have been tried by me and others upon
" hemp covered cables."

"There is one cable which has been in the water for "some months, and the Committee will see that the "hemp has shrunk so as to force the core right "through, and in many places forced the copper "through the gutta-percha, showing that hemp alone "is not a proper material to cover a cable with. "First of all, it is much too elastic; this cable will "stretch 4 or 5 per cent. before it breaks; when it "is once got into the water, the tendency of it is to "shrink, the outer covering will shrink; the gutta-"percha will try and shrink, but being held back by "the copper, it is prevented, unless it forces the copper "to shrink with it, and then the copper knuckles out, "so that this hemp covered cable has been proved "to be perfectly useless for the object for which it "was intended; the failure must be attributed to the "want of proper materials having been used in the "manufacture of the cable, and not to any fault "inherent in the core itself as a core, or in the manner "of laying it, as laid down by Mr. Newall."

I quote the entire passage, for it must be remembered this gentleman was the Engineer of the Government when this strange contradictory evidence was given; and the public should know what value to place upon such statements, and the danger of one landsman examining another on nautical questions of such magnitude. If a seaman had been on the Committee, the public would have been shown by the evidence itself that Mr. Gisborne either knew nothing of the subject on which he gave evidence,

or that he was, no doubt, involuntarily deceiving the Committee.

He tells us, on the one hand, that the ship hung on to the cable for thirty-six hours, in 1,500 fathoms, when it was blowing hard, before any electrical damage was done to it, which must be admitted is the best practical proof of its vast superiority, for no other cable was ever known to perform such a feat; and then he complacently tells us that such a cable is useless, and that the hemp shrinks so much that the conductor knuckles out of the rope, a statement so utterly without foundation, and so perfectly opposed to common sense, that one can only exclaim, there must be some mistake, for no man could seriously make it. The simple fact is, that any cable made entirely of hemp, on being submerged, instantly absorbes the water, and closes so tightly upon the conductor throughout the whole length, as to be mechanically impossible for the wire so to accumulate at one spot more than another that a knuckle could be formed. Let any man put a foot, or a fathom, or any other length of hemp cable into water, he will inevitably find the core, of whatever material formed, so pressed upon by the strands of the rope that it could not by any possibility take any other form, however much the fibre itself might shrink.

It is true that some rope will shrink more than others, simply because the fibre differs in quality and character; and the mode of its manufacture also makes some difference. But the utmost shrinking I have

ever known is about 3 per cent.—say $\frac{3}{8}$ of an inch to every foot—and every inch will have its share of this contraction; if it lie submerged for years no further contraction can take place. I have had a considerable length under my own eye submerged for six months, watching it from day to day, but not the least change took place.

It will be readily understood that this $\frac{3}{8}$ of an inch in each foot of conductor (being metal) will not shrink; and it will be asked what becomes of it? The answer is very simple: it is taken up by the slight and almost inperceptible undulation and small hollows or "lays" between the strands of the rope, which are there as if designed by nature to receive it: this is the simple state of the case, which Mr. Gisborne seemed not to understand. He had not, like myself, been a life time in constant connection with ropes, and we may therefore excuse him.

With regard to the danger this gentleman apprehended from stretching the cable—while he unwittingly made clear, I must repeat, that even with the ship riding to it during a storm of thirty-six hours, in a depth of 1,500 fathoms, when its utmost strength must have been tried, however carefully any sudden shocks upon it were avoïded, its solidity was amply proved. But to give a fair and simple illustration, we may refer to what constantly happens on board ship. A shroud or backstay of new rope is only moderately tight on a fine dry day, but the effect of some hours of rain is unmistakable; it has become

so hard and so severely tight as to be even in danger of breaking; this makes it clear that if there had been a wire or any other material in the centre, not subject to shrinking, it must lie in the undulated form I have above described, ready however to yield when the rope has got back again to its dry and soft condition. A still more familiar illustration, though on a smaller scale, may be seen in the domestic clothes line that tightens to almost a breaking strain during a wet night.

It is, then, indisputably *clear that a hemp cable, even at its breaking point of tension, will not elongate when it is wet to its original length when it was dry; hence, no tension can come upon the electric wire submerged in a hemp cable properly made, because the tension is balanced by the contraction.* It is true there are causes for untwisting common to all cables, whether of iron or hemp, from improper manufacture, or from being put into unpractised hands for management.

Whale lines, for example, have been in use for centuries, which run out at a speed of 10 or 12, or more, miles an hour, and there is no chance of them kinking, though they run from a simple coil, because they are properly made. Yet even in such a perfect condition no landsman could handle them, and sailors alone could properly manage such ropes.

Just so the telegraph cable can be made to do its work if manufactured according to the instructions of a seaman who is master of his profession.

This important witness has evidently had the ad-

vantage of the committee, composed of gentlemen who could not dispute practically any statement he made; they were no doubt satisfied he was under these impressions, and it was taken for evidence, when a little practical cross-examination would have saved both them and the country from much serious error. The tests of which he spoke were altogether deceptive, if the public is justified in putting a construction so charitable on his evidence, after the transparent attempt to advocate iron cables, when, by his own admission,—I must repeat—a hemp cable had proved itself superior to any other on the most trying practical occasion.

By way of illustrating his statement, a drawing of the Gibraltar cable, in a fractured condition, was given in the appendix; this was perhaps the nearest approach to a hemp cable that the committee have thought worthy of a drawing, and of which it is stated—

"Contraction in the length of the cable caused the "core to be forced out between the strands of outer "covering."

Now as this statement, coming from such a source, may mislead some of the most ardent supporters of Ocean Telegraphy, it is necessary to put it in the most practical light, seeing that no explanation was elicited on the subject of testing this cable. A seaman would have had the following questions answered:—

How much hemp and how much wire were there per fathom in this cable?

How long had the cable been under water?

Was it put under tension while it remained in the water?

Did you examine the amount of shrinking?

And how much did it actually contract per fathom?

Did not every inch of its length partake of the shrinking equally?

Tell us then from whence came the slack wire that knuckled out as you say?

It must be admitted that the wire pressed between the strands of a hard wet rope could not slip, how then could there be any accumulation of wire at one particular spot of which a knuckle could by any possibility be formed?

What was the weight of this rope in water per fathom?

Do you seriously think a weight so great as this in 2,500 fathoms could with safety be controlled *during a strong head gale*, when a ship could progress only a mile or two miles an hour?

If the ship laying the cable should be *compelled to lie to for the safety of the ship* whilst the cable was running out, tell us how a weight so great, suspended by a cable so small, and the ship labouring so heavily in the sea, could be controlled and made secure?

You admit that such dangers might arise, even in summer time, and it is by the character of the cable to provide for them, in fact, it is in the character of the cable alone that such dangers can be provided against.

It is now admitted on all hands that a cable, made exclusively of iron or steel, is too heavy for deep water; and if there be a mixture of hemp *and* iron, or steel, though some trifling additional strength might be secured, it is over-balanced in deep water by its extreme weight, and great danger to the integrity of the cable is incurred by corrosion, which destroys both the iron and the hemp: the mixture could not therefore be safe; besides, I must repeat, iron so increases the specific gravity of the cable that in extreme depths, whether it be hid within the hemp, or whether the amount of wire be large or small, the same principle is at work, its own extreme weight increasing renders it uncontrollable and destructive to itself. Therefore iron, on every account, should be entirely excluded from Ocean Telegraph cables.

To what then can we turn our attention but to fibrous substances?—to hemp of the best description or the best mixture of it, *and to its infallible preservation from the many causes of corruption to which it is subject.*

I would observe with sincere deference, in passing, that when England, through her representatives, appoints a committee of inquiry into any important subject, it is at least expected that it shall consist, so far as possible, of a sufficient number of men practically and scientifically acquainted with the subject under inquiry, with as many as can aid it in any of its collateral and indirect bearings: such is invariably the character of the committees appointed by either of the Houses of Parliament. If the subject is for-

tifications, military men are carefully selected to form part of the committee. If harbours of refuge and coast lights be the question, the most practical seamen are selected; and if the inquiry be one of law, equal care is taken to appoint to the committee men of that profession. And, moreover, when such committee is formed, the best possible evidence must be had, come from what quarter it may, regardless of cost. After so much care, first as to the formation of the committee, and then as to its plan of operation in prosecuting the inquiry, the public cannot be otherwise than satisfied that there is in fact no room for complaint. Now, if this course had been observed by the Board of Trade Committee, who have lately issued their report on the subject of Ocean Telegraphy after a long and deliberate inquiry into that momentous subject, there would have been no room for complaint, and the subject itself might indeed have been exhausted; the Report might also have contained clear and well-defined opinions and recommendations, based so unmistakably on the evidence, that the public might rely that the problem had been completely and perfectly solved.

This happy consummation, however, has not been attained—and why? simply because none of the conditions on which Parliament conducts such inquiries have been observed.

The subject of inquiry, though not exclusively, was pre-eminently one of nautical science, namely: How shall a cable be constructed to secure safe deposit

of the electric wire at the bottom and across the Ocean? Yet no sailor was appointed to take part or share in the responsibilities of the committee. Several nautical men were examined, it is true, after a fashion that could not possibly elicit any useful information on the real points at issue. We find sailors led into questions that belong to the electrician; and both engineers and electricians into matters which belong to the sailor, just for the want of the nautical element in the committee, *the entire absence of which cannot but stamp the Report as a decided failure*, and it could not be otherwise.

With regard to the mode in which the inquiry was conducted, even supposing the committee had been properly constituted, we may say, as it was intended to be a great national inquiry into a question of the greatest possible importance, no reasonable expense should have stood in the way of obtaining the best possible information. But there seems to have been no effort made to secure this from any quarter except from those persons immediately about London, who had been directly or indirectly concerned in all the failures of laying deep sea cables; truly this is a negative mode of obtaining evidence, but surely it was not the most reliable or extended source from whence to obtain it. It may be said this was not the broad principle by which the country had a right to expect their great inquiry should be conducted, nor the way to secure credit in the eyes of surrounding nations, for thorough examination of a subject in

which they were all concerned, and who have suspended their own inquiries under the assurance that it was being thoroughly sifted and exhausted by the great committee sitting in London.

From these nations we hear of no contribution to the information obtained. There was no evidence invited from the great schools of France or Germany, either on one branch or the other of this vast subject, the importance of which seemed to demand after the continual failure to lay cables in deep water, that the committee would offer a premium for the best solution of the whole problem, or for each department of it separately, irrespective of country. But strange to say this mode also of obtaining information has been considered unnecessary.

It is not very pleasing for the public to be thus driven against their will to believe that there must have been a latent unwillingness to seek genuine practical information from any quarter but from among themselves, labouring under the strange delusion that they knew all that could be known. We are told that no man possesses greater wisdom than the knowledge of his own ignorance. If this be true, the character of the report is accounted for. Elaborate as we find the document, it expresses no settled and decided opinion on the subject of inquiry. Though *a light cable is recommended*, there is no unmistakable character given to it. It is satisfactory to find, however, that throughout the inquiry there are ample reasons for the recommendation. Taking the evidence

as a whole, it is impossible to understand how iron in any shape should be employed in the construction of the Ocean Telegraph cable, though some of the witnesses have done their utmost to support iron or steel cables, and others a mixture of these metals *with hemp*, and have strained every point against the exclusive use of the latter material.

Having already called attention to the evidence of Mr. Gisborne, the Government Engineer, who was the first person examined by the committee, I will now venture some practical remarks on the Report the committee have drawn from the evidence; and though they do not own frankly in as many words that a *simple hemp cable*, properly preserved from the effects of the destructive animalculæ *with which some shallow waters abound*, is, after all, the only solution of the problem that can really be arrived at; I will undertake to prove from the words of the Report that such is the unmistakable conclusion to which they have arrived.

No doubt the committee, composed, as it was, of gentlemen of great eminence in their several professions, laboured with much credit to themselves individually to find out the remedy for the serious losses sustained by adventures in Ocean Telegraphy, and determined nobly to repair the damage they had themselves, in some degree, been instrumental in doing; like a good persevering school-boy, who seeing error in the problem he had to solve, would allow no one to correct it but himself. Good as the character-

istic may be, it can be carried too far—which has been the case in this inquiry. Electricians and engineers have much reason to be proud of what they have achieved in their respective departments of science, and England especially has much reason to be proud of them; but in this particular case they have attempted too much, for which they are much less to be blamed than if they had not persevered at all. The committee was amply fortified with professional men of every branch of the subject, except of the nautical profession, which was most inconsiderately shut out from participation in the responsibilities of the inquiry, though there were gentlemen of both the Royal and Commercial Navy at hand eminently qualified to examine the subject nautically to its core.

I would not presume to judge who is responsibe for the omission, but when the committee was first proposed, it was urged upon the leading gentlemen upon it, that the main consideration was to have the nautical profession well represented in it; and in the Report we find the committee giving a remarkable proof of the necessity, by saying (page 31): "If "in spite of weather or tides the vessel could infallibly "preserve a moderate speed across the Atlantic, the "laying of the cable would involve but little risk. "As long as the weather is calm, and all in good order, "the operation is an extremely simple one, requiring "only proper care and attention. But in heavy "weather, when the vessel is pitching and rolling "to such an extent that the men can scarcely keep

"their feet in the hold, while unlashing and freeing "the cable, where surging of the vessel throws sudden "and unequal strains on the break, and more especially during dark nights, when the breaksman "himself can scarcely keep his place and can see "nothing of what is going on around him, the difficulty is of no ordinary kind."

With all these dangers so clearly before them, when the practical skill of a seaman is so essential, and which so imperatively demand a peculiar description of cable, it really seems odd that a seaman was not the very first man called on for advice under such circumstances. But a strange notion has prevailed among landsmen that all difficulties were to be overcome by some cunningly devised *paying out machinery*, and nicely contrived breaks, on which very large sums have been spent in vain, for they still find that the complex and violent motion of a ship in a sea-way is not to be met by any such contrivances.

It must be reiterated a thousand times over: the simple and only effectual way of meeting these various difficulties that have so bewildered landsmen, *is to adopt a cable of light and properly regulated specific gravity*, which will require no restraining appliances, but simple machinery such as will deliver any given or desired amount of slack cable, over and above the speed of the ship from which it is running; so that as *a whale line* runs from the coil in a boat, so would the Telegraph cable run with equally clear and unmistakable regularity from a ship's hold. The simplest

arrangement most assuredly prevents either kink or foul, however violent may be the storm or the motion of the ship.

Imbedded in the centre of such a cable would lie the electric conductor as safe and as free from harm as if it rested in a case of feathers. The effect of the water on the cable is to tighten and press the fibrous sheath upon the insulation, keeping the electric wire exactly in its proper place from which it cannot possibly move; and as to knuckling out between the interstices of the strands, as some interested persons have had the hardihood to state, that is simply impossible: because any collection of the wire conductor at one spot more than at another could not take place. This cable on reaching the water contracts, and the fibrous material so tightens as to prevent the electric wire from taking any degree of tension; and like the sounding line, as I have so often said, it can be recovered again from any extreme depth. Such is the cable the columns of the *Times** did me the honor to recommend more than two years ago; but the Report of the committee suggests another danger on which I must add a word.

At the same page (31), it is said—" The laying " of the cable should be uninterrupted from the " beginning to the end of the journey, and with this " view no derangement should be possible either in

* All the experiments in very deep seas, tend to show that the principle of a rope-covered wire is the right one after all.—*The Times, 30th September,* 1858, *on the Atlantic Telegraph.*

" the machinery connected with the break or in the " engines of the vessel. The speed also should be " maintained as uniform as possible, whatever may be " the weather."

Now the hemp cable in itself provides for all these contingencies. It has a peculiarity which in no way belongs to iron cables. Being so light in water, supposing any difficulty to arise on board—the engines disabled, and requiring days to repair, or a collision such as happened in the Mediterranean some time ago, or any other such disaster—this cable, being made to run out in mechanical connection with a buoy, in an instant, by the mere touch of a spring, the cable is fast to the buoy and detached from the ship, riding safely with a light or flag flying, so that it may be distinguished some miles from the ship, and can at any convenient moment be recovered.

If Capt. Dayman had been thoroughly examined by a seaman, it would have been made clear to the public mind, that as truly as his sounding line and lead had been recovered, so would the hempen Telegraph cable be made secure, even in such extreme cases, by the use of a properly regulated buoy—the cable being made of sound material, and its specific gravity properly attended to.

We have been speaking of cables for deep water in the Ocean; but the committee have so mixed up the requirements of deep water with those of shallow water and shore ends, that you will have to mark well the distinction.

In deep water, for example, we need not speak of destructive animalculæ, because all parties agree that at great depths a cable of any kind would not only lie perfectly quiet, but free also from destroying insects. With regard to shallow waters the cable could be readily lifted for repairs; nevertheless, it is essential to provide against destructive animalculæ; and as no tarry substance can do this, we apply a solution that is held in chemical combination with the fibre, and which permanently defies every destructive insect, or even the worst effects of animal and vegetable corrupting matter. This has been proved by exposure to them for years. This solution belongs specially to the cable, therefore I describe its effects rather than its components, though in time it will doubtless take the place of tar, &c., for all kinds of preserving purposes, its cost being much less and it being much easier of application.

Having given a short and incomplete description of the cable, it may be well to show that this very cable is clearly recommended by the committee.

Page 26 of the Report we read thus:—" Wire, " however small, will break with its own weight at a " length of about three miles, and an iron rod, how- " ever large, also breaks at the same length; the " strength being, of course, in proportion to the area, " and therefore in proportion to the weight. In " dealing, therefore, with deep sea cables, it is evident " that the strain cannot be varied by a change in the " size of the cable itself, *but by the alteration of the*

" *specific gravity of the substance employed.* The spe-" cific gravity of hemp is little greater than that of " water, and consequently no strain occurs with " hempen cables, whatever be their length."

No statement could more conclusively admit the great fact that iron, on account of its extreme weight, is unfit for deep water telegraphy; and hemp, on the other hand, is also conclusively, on account of its specific gravity, the only suitable material. It clearly and logically follows that the only rational course for the committee to follow was to inquire by what means the electric wire could be safely embedded in the hemp cable, so that it might be securely laid on the bottom; this once done the problem might be considered as solved. Considering also, that it is admitted on all hands that there is no abrading cause to be apprehended in deep water, after the countless proofs we have that as the cable falls there it will lie free from the effects either of motion or "tereds." And I must here again repeat that as the sounding lead evidently goes to the bottom, and by means of a tiny hempen line brings up specimens of it, so we may safely and reasonably conclude that a telegraph cable made of hemp would not only be safe for laying the electric conductor, but would also be easily under-run for repairs in case of need. We are not now discussing as to what quality of hemp, or of what mixture of hemps, such cable should be made; but inasmuch as *mineral is unfit, and animal material, such as hide, &c., is entirely out of the question,* we have only to

turn to the vegetable kingdom, and we find the very material that in every point turns out to be by nature designed for the purpose, only providing, that its proper and judicious application as to quality and manufacture be secured. It is true Mr. Newall tells us he has three times failed in laying a cable from Candia to Alexandria, and he says (Report, page 11) "The "greatest depth is 1,750 fathoms. In one instance a "hemp covered cable was used, and failed in laying; "it was also found that the tereds had eaten through "the hemp and indented the gutta-percha; that the "hemp covering did not enable the cable to be raised "from deep water."

Now this was one failure of hemp, but there were two of iron.

To see the true character of Mr. Newall's evidence before the committee, we must see it as reported in page 256, No. 4504, as follows:—

"With regard to hemp-covered cables, we found "in the Levant cable, that, with the great weight of "hemp outside, the small strength of the copper wire "conductor was not sufficient to raise the cable; in "about 400 fathoms the insulated wire always broke."

If the committee had at once questioned the quality of such copper wire conductor, which is calculated to stretch 10 per cent. or more, when a properly made cable of hemp, even when dry, would yield much less, and in water still less, if any at all, we should then have had a fair state of the case; but the animus against hemp cables is so transparent in this bit of

evidence that it should be marked well. He speaks as if the hemp cover was a mere piece of lumber, and as if the copper conductor had to bear all the lifting of the cable. And then he was asked—

"Are you aware the hemp undergoes any injury "from deep water?"

"We found in the Levant that it was completely "eaten through in pieces of about an inch in length, "but in the deep water the pressure did not seem to "produce any effect. I think the water in the course "of time will rot it."

To condemn hemp cables, he makes it out that tereds destroyed it, and then, as if it should have another death, he says he thinks the water in course of time will rot it. No doubt such cables as he made would be so destroyed, even if they escaped destruction before reaching the water. In a few weeks, while lying in a steamer's hold, the very tar is destructive of the fibre; in such climates, and wherever the tereds are, its destruction in a few weeks is inevitable.

Again in the same page, 256, No. 4509, he further says, "We had had no difficulty in laying down that "cable, and what we did take up the gutta-percha "did not appear to be in the slightest degree injured "by contraction or elongation." And yet he had just before said the copper conductor was broken, which, before breaking ought to have yielded 10 or 15 per cent., but however little the stitching had been it would have shown materially on the gutta percha. All candid observers capable of thinking on such matters

will admit that such statements are worse than useless as evidence, that they reflect severely on the witness, and are utterly unworthy of any weight in the committee's report.

We now come to the committee's "General Conclusion as to form of cable," and at page 35 we find the following passage:—"For cables beyond the "reach of anchors, and even of strong currents, it "may be necessary to employ iron or steel wires to "obtain the necessary strength for raising for repairs, "either during laying or after they are laid * * * "The iron or steel wire must be protected from cor- "rosion by means of some outward covering. We "think such an outer covering is to be sought in "tarred yarn, protected by some cheap compound of "gutta-percha or india-rubber. The wires by which "strength is given should be laid on longitudinally, or "with a very slow turn, and must be kept in place "by a spiral binding, or by means of the covering "compound. Cables of this general form may also, "we believe, be made applicable to the greatest "depths which will be met with. In any case the "outer covering should be so devised as to prevent a "strain coming on the core, and the specific gravity "should be adapted to the depth and be such as to "ensure the cable sinking evenly."

Thus the climax of the great inquiry has been arrived at, and after all the pros and cons the committee believe a cable of iron or steel may be made applicable to the greatest depths, though they have just before

stated, and stated truly, that in any form iron would break itself by its own weight in a depth of three miles. They also go on to recommend the steel and iron to be protected from corrosion by tarred yarn which, on a moment's reflection, though it may prevent rust when dry, yet in a ship's hold, exposed to occasional wet and the action of the air for months, the tarred yarn would be no protection whatever. Corrosion, they have truly told us, at one spot, would endanger the whole; and as to covering the cable with either gutta-percha or india rubber, unless they were vulcanized, which in this form of application is impossible, the heat of a ship's hold in summer, or in a tropical climate, would in a few days destroy the integrity of these materials; and, besides, cables made of longitudinal wires would possess several impracticable qualities. In the first place, it would be next to impossible to coil it, and equally difficult to make the wires bear strain alike over a pully however large its circle; splicing it efficiently would be quite out of the question, and the entire weight of such cable in deep water, coming upon the upper wires on the pully, would either break or press into and destroy the insulation.

But, happily, there is a redeeming clause in the conclusion of this passage which points unmistakably to the only cable that can be used in deep water—one that will coil without trouble in the smallest compass—one whose every fibre contributes to its perfect efficiency—one that is perfectly spliced with the greatest facility—one that bids defiance to corrosion

or corruption—one that, in a word, protects the electric conductor from every harm, holding it in a bed where nothing short of wilful violence can disturb it.

The clause to which I refer I must repeat; it runs thus:—

"In any case the outer covering should be so "devised as to prevent a strain coming on the core, "and the specific gravity should be adapted to the "depth, and be such as to ensure the cable sinking "evenly."

Nothing but a hemp cable, it is clear and obvious, could meet these requirements, and be so completely under control when being submerged in deep water. In a word, a cable made of any other material would not so contract as to take the tension from the core, not that a cable made of hemp necessarily becomes shorter on being submerged, for the rigidity of the core may prevent this, nevertheless, the hemp contracts and tightens to an extreme degree, and takes the tension all the same, even in its helical or spiral form, and will not admit of any strain coming upon the electric wire.

On the other hand, a cable made of iron or steel cannot be so affected by contact with water; it cannot shrink, and its weight which is so great in deep water must first of all come upon the straight conductor, and then its only chance of existence depends upon its capability of elongating.

The next clause of this passage (page 35), describing the formation of the core, says:—"the core

" must be protected by a covering of gutta-percha, " and the whole served round with tarred hemp to " form a bed for receiving the protecting external " wires."

This remark also claims special attention, the recommendation being open to several objections which may sound like repetition; but, in the first place, tar or any tarry substance is not only unnecessary, but as it takes the place that should be occupied by other material, it is therefore dangerous. Hemp, however, saturated with it, will in a few days' exposure to damp confined air in a ship's hold, become heated, as for example in the Gibraltar cable by Mr. Siemens—decomposition in such cases becomes very active; and after such cable has been placed under water for testing the tarred hemp underneath, the wire will more readily rot than when dry; it is therefore dangerous.

Another objection to it is that the diameter of the cable is inconveniently increased in proportion to the quantity of hemp applied, without contributing any strength to the cable; as for example, the Atlantic cable had about 100 tons of common hemp saturated with tar wrapped about the insulation at great and useless cost, giving no strength whatever to the cable, and intended merely for the wire covering to lie upon. The tar it contained did not prevent it from holding water: and when water once got to it, there it remained to the corroding destruction of the iron wire.

It is not my present purpose to remark upon the character of the wire conductor, or the mode of insu-

lating it. These are two most important subjects which must be dealt with on another occasion; it may, however, be desirable to offer a remark or two on the next paragraph of the Committee's general conclusions (page 35) as to "Laying and maintaining Sub-marine Cables."

"Before the route in which a Sub-marine Telegraph "cable is to be laid is decided on, a careful and "detailed survey of the nature and inequalities of the "bottom of the sea should be made."

This recommendation suggests the inquiry as to what has already been done in that department. If they had turned to the chart they would have seen that in one direct line across the Atlantic, some 40 miles apart by about 50, soundings, the depth of water, and in most instances the character of the bottom had been obtained; it is possible to arrive at the approximate cost of time and money at which this meagre bit of information had been got; and as no survey of this kind could be of any practical use until a very large area of the Ocean had been so examined some 5 or 6 miles apart, not only the enormous cost but the time required for doing it would carry it beyond the reach of the present generation, and occupy much more money than several cables would cost.

Having once ascertained that the bottom of the sea is perfectly tranquil, and whatever descends there, can be subject to none of the causes of dissolution that exist in the air—that no abrading effects are there—

and also that a simple hemp cable can be so perfectly controlled in paying it out *as to be made to adapt itself to the undulations of the bottom* so completely, that such survey of the bottom as the Committee recommend, is rendered as altogether unnecessary as it is impracticable.

In the same page (35) it is stated:—"The "failures which have occurred in laying Sub-marine "cables are mainly attributable to the employment of "ships which have not been constructed for the "purpose, and of defective paying out apparatus. "This latter must depend so entirely upon the form "of cable to be used and the depth in which it is to "be laid, that it must be left to the Engineer to "devise in each case."

Such opinion is very natural to come from eight, or indeed, any number of landsmen. But if there had been a smart seaman on the Committee, he would have shown conclusively that the faults did not lie in either the ships or machinery; but in the character of the cable, I am bound to repeat—which, in deep water and bad weather, could not be controlled by any kind of machinery—neither can a ship, even of 5000 tons, large as it is, avoid violent and complex motion in a storm, which would be destructive to any iron cable—however perfect may be the machinery, or attentive the engineer. A seamen would have shown the Committee also, that there are storms during which a ship, however powerful, can make no head-way, and which would be certain destruction to a steel or iron

cable. *But even in such a gale a hempen cable would be perfectly safe*, and, I repeat, under complete control as to paying it out; only requiring the simplest mechanical contrivance. And as to any special construction of a ship for stowing the cable—however necessary this may be in the case of iron cables—it is by no means required for those made of hemp, only so far as a ship is capable of being fitted for any special purpose, might as well have her space turned to the most convenient account. The hemp cable can be coiled perfectly clear for running out in small coils, as well as large, in any part of the ship, to suit her trim, which is a point of the greatest importance for her safe management.

Thus we have every quality that such an operation can demand, in the simple hemp cable.

There are, however, various other valuable peculiarities with respect to splicing, preserving, shrinking, &c., which it is not necessary to enter upon here. I therefore pass on to observe briefly, in conclusion, upon the recommendation of the Committee, as to "Contracts for laying Sub-marine Cables."

"If the contractor is made solely responsible for "the safe laying of the line, he cannot be made "subject to much interference by other parties, but "he will put on a large additional price to cover the "risk he incurs, and the extra cost to be paid does "not secure the success of the enterprise."

Nothing could more clearly show that the final making or covering of the cable must inevitably and

entirely be under the control of the Company, whatever kind of contract may be made with the manufacturer.

The Company, let us suppose, consists of 30,000 persons, holding each a share of £20 value in the enterprise: thus the capital so broadly distributed, if it were lost, could hurt no one; and if an individual should own a large number of shares, he can subdivide them among his friends, or insure with underwriters, as he may desire.

The Company, or its board of representatives, being so situated, have no right to make contracts with individual manufacturers under a notion of imposing the risks of the enterprise—which are already so subdivided—on any individual contractor, with whom rests the entire responsibility; and if he fail, all is lost. Any mere guarantee he might give, would not compensate for the loss of time. He may risk his own ruin, which is the only satisfaction the Company would have if the cable is lost. No! the Company in choosing its board, is supposed to have among them some practical men in each department of the work, whose duty is to see that the Company's money is properly spent in the purchase of material, taking proper advantage of the market; and when the board have fully deliberated on, and made their choice of the kind of cable to be made—contracts for making it, under the constant and special supervision of the Company's practical, well-selected, and well-paid officers—subject to such checks as may be most

consistent with the perfection of the cable, as well as with the strictest economy—every day's work being subject to the scrutiny of the general Board of Management, in any form they may see fit. After all this, the cable should be tested thoroughly under water, and then handed over to the party in charge of coiling it on board, and laying it down in its final destination.

We look in vain for a reason why a contractor should take all these operations upon himself, and hold himself responsible for the chance of getting a monster profit, supposed to be adequate to the risk, when in fact he can give no sort of real security; but in case of accident or loss, flies to some doubtful or saving clause in his contract, under which to shelter himself by law, in case of need, from ruin.

A proper and wide spread distribution of the shares is all that is necessary to secure the public from any undue risk on the one hand; and a practical, well chosen Board of Management, that can deal with each department of the work satisfactorily to the public, must be admitted to be as good security for its successful accomplishment as can be had or desired on the other.

As a fleet of ships is sometimes held by many hundreds of persons in shares of £20 each or so, and its management entrusted to well-selected practical men—as for example the Peninsular and Oriental Company—insurances become unnecessary, from the fact that a loss, however severe, is not felt when it

is spread over so large a number of proprietors; and for those who choose to embark largely in such an enterprise, the management of good practical directors will doubtless reduce the premium of insurance among underwriters to a low rate—especially when they see also that as truly as Capt. Dayman, Capt. Maury, and others, have been letting down and hauling up safely *a line heavily loaded with lead—a line made of the same material as our cable*, in the deepest water of the Atlantic; it clearly and most logically follows that the Telegraph cable is even safer to be recovered than the line; and taking the average losses of the sounding line as a guide for the underwriter, the risk will be found equal to a very moderate rate of premium.*

These are the natural and justifiable conclusions to which the Committee could have come; and in the face of Europe and America, as in entire accordance with practical science, they were bound in justice to

* In a commercial point of view it will be interesting for underwriters to note the Report addressed to Rear-Admiral Washington, F.R.S., &c., hydrographer, by Mr. R. Hosking, in command of H.M. Ship "Porcupine," in June, July, and August, 1862, on his deep sea soundings to the west of Ireland.

This excellent surveying officer has presented us the result of his labours in a tabular form, by which we learn that he obtained forty-eight soundings, and thirty-one of them procured him specimens of the bottom, proving the whole line and sounding apparatus had been recovered.

And three other casts brought up the lead, but gave no indication of having reached the bottom.

every party and interest, and above all for the success of the great cause of Ocean Telegraphy, to declare a simple hempen cable, well made of the best material, and thoroughly preserved from the effects of corrupting influences, to be the only true solution of the problem.

The remaining fourteen soundings brought up the lead from the bottom so far as 100 fathoms, and, in one instance, 900 fathoms before the line parted.

Thus thirty-four out of forty-eight lines were recovered, though loaded with a sounding apparatus of considerable weight. And the fourteen lines that were *partially* lost, clearly proves a more perfect system of hauling in the line to be necessary. The greatest tension that could come upon the line, viz.: in lifting the sinker from the ground had been overcome, as for example, one of the casts, in a depth of 1,900 fathoms, the line broke when 900 fathoms had been hauled in, showing clearly it happened by accident, or for want of a simple compensating apparatus for preventing any sudden or undue tension coming upon the line.

Nothing could more conclusively prove to underwriters, that if a telegraph cable be made of the same kind of material as the sounding line, viz., hemp, instead of the iron wire that has been so persistently, and so fatally used, there would be very trifling risk of laying it safely; and if it should require repairs, the light hempen cable is recoverable as surely as the sounding line; and so the risk is brought within a moderate rate of premium, when its electrical condition has been properly certified on being shipped for submersion.

SOURCES FROM WHICH REVENUE IS DERIVED BY OCEAN TELEGRAPH LINES.

It is asked from what sources will the revenue to Ocean Telegraphs be derived, supposing a wire to be safely laid across the Atlantic.

The answer is simple and might be summed up in few words; but communication of this novel kind over the Ocean so changes the character of both commercial and social usages, that no statistical data can be produced upon which to base a calculation. When the telegraph line is once available, the commercial community will feel its use a necessity; the earliest, most reliable, and independent information will become essential, so that all may keep pace with each other. It is well known that by the bare reduction of postage from 8d., on the average, to one penny, commercial letters were increased in number more than ten-fold; not only, however, by commercial houses increasing their letters, but chiefly by increased correspondence between those to whom high postage had been a bar to frequent communication. Correspondence formerly went through various indirect channels. The same principle will doubtless operate in the use of a telegraph line between the two hemispheres; in addition, new emulation will spring up between leading commercial establishments, all desiring the earliest telegraph information, utterly regardless of cost; and this remark applies to every

branch of commerce, not in one country only, but in every city and district in Europe and America. *Bankers, stock and share brokers, the cotton trade, the corn and flour trade, iron trade, timber trade, tobacco trade, shipowners, brokers and insurance establishments* in large numbers *must all have independent information constantly transmitted;* and the leading journals of Europe would not be considered complete, without the *last few hours news* from America, nor would the thirst for European news be satisfied unless the very latest was transmitted to America.

How is it possible to estimate the vast demands upon an Atlantic telegraph? The line laid between France and England supplies no parallel, the two countries being within two hours' sail, and the capitals only twelve hours apart by post, thus rendering telegraphic communication commercially less necessary; the other parts of the continent are also within a few hours' post; and though there are several wires at work they refer only to the states of Europe, and therefore supply no data for estimating the amount of telegraphic intercourse between Europe and America.

The next consideration is the social aspect of the question, from which we may also draw important conclusions and valuable practical results. It will be admitted that almost every district of Europe has contributed more or less to the vast and rapidly accumulating population of continental America, and from the relationship of divided families, extending over some millions of the population of both hemi-

spheres, we may reasonably conclude that if the charge for a message be on a moderate scale, special communications from this source will be very numerous. Announcements of departures, arrivals, changes of residence, orders, counter orders, and numberless incidental occurrences, domestic and otherwise, will be communicated, whether the necessity be real or imaginary. The very existence of the line will invite and even create many wants that would otherwise never have existed; there is no parallel for this in the lines existing on either side of the Atlantic. The social intercourse over any other submarine line is limited mainly to travellers, but between America and Europe both the settler and the traveller must contribute their quota, though to estimate their value to the line is impracticable, till the cost of messages is known, which must be regulated by the amount of the demand and by the facility with which they can be sent. Much might be said on various other demands on the powers of the wire, but we may leave aside the *religious* and *charitable*, as well as the *cientific* requirements, and pass on to the next sources from whence revenue will be derived.

The imperial or state demand upon the Electric Telegraph across the Atlantic, may be placed first on the list. It certainly differs widely in character from every other, because *state necessities* are concerned; *ministerial*, *diplomatic*, and *consular* communications must be made as early as practicable; and though written documents may follow, the bare

announcement of their departure and receipt must be sent by the telegraph, if for no other reason than that the means are available. State management of the present day, in both hemispheres, demands this. All the European colonies and dependencies in the West partake in this necessity of sending their earliest news by telegraph to the mother country; and *Mexico*, *Brazil*, *California*, *Peru*, *Columbia*, *Chili*, *Cuba*, *Jamaica*, and a host of other places of minor importance, will send their most important information through the electric wire to Europe. On the other hand, all the states of Europe will not only acknowledge the receipt of such messages, and answer them, but will also send instructions in this way to their naval and military commanders. The public importance of this cannot be over estimated; the cost of such messages, however long, being of no consideration whatever. Letters and official documents may follow the telegraphic instructions, only as a confirmation of what will have been received and acted upon some weeks before their arrival; and considering the number of states thus contributing to the electric telegraph across the Atlantic, it is not unreasonable to calculate that such demand will be so continuous as itself to employ at least a single wire.

A volume might be written on the subject, every page of which would show that twenty telegraph lines in full work between Europe and America, would scarcely suffice to meet the demand for transmission.

But to make calculations as to the revenue or demand upon a telegraph across the Atlantic, *on the*

basis of numbers of populations, or *on the amount of commercial interchange* of commodities, or on the number of letters transmitted from one country to the other, in any given period alone; is to leave out of the estimate the only special elements on which the calculation can really be based; namely,—*First:* The vast saving of time, which in all cases is equal to money. *Second:* The competitive, commercial, and social impetus to international intercourse, which has been already so much felt in the separate states of both Europe and America. *And thirdly:* It may be added, the transcendent importance of one message over another. We have only to reflect on the importance of saving a day in the passage from one country to the other. To accomplish this alone, states have largely contributed their money, and individual enterprise and ingenuity have been put to the most costly stretch; but how inestimably more valuable will be the means by which news of last evening from every corner of America may be on our breakfast table at eight o'clock in the morning. Who can estimate by any conceivable calculation the value of such a leap over 2,000 miles of sea? and whence can we derive data on which to base a calculation of the profits to be derived from the discovery and application of such a road from one continent to the other?

When twenty electric roads shall have been made, each doing its work, it may then, and not till then, be necessary to inquire into the propriety of increasing their number; but a moment's reflection will do away with all doubt whatever, as to the value that must

be put upon the first line of communication between those great peoples who are so intimately united by blood, and by interest of every conceivable kind.

And it will be admitted that those who are successful in accomplishing this laudable work, will both deserve and obtain the honor as well as the pecuniary advantages which must assuredly be the result.

The boon will then be rapidly extended to every corner of the globe, and the great human family will share in the benefits so wonderfully conferred by the agency of an electric shock!

These remarks—necessarily brief—only in a faint degree show the advantages to be derived from transatlantic telegraph communication.

ADDRESS TO THE IMPERIAL COUNCIL OF STATE.

Having from an early age for some years commanded ships passing across the Atlantic, Pacific, and Indian Oceans, I incessantly devoted myself to the study of those extreme deep waters with a view to the development of natural science, which seemed to be of no practical use until the year 1857, when a telegraph cable was being made to unite Europe and America. On examining the character of this cable, my old studies flashed fresh to my recollection.

Many years having passed, during which I had been occupied in manufacturing cables on an extensive scale, which practically strengthened my convictions

as to what was the most consistent character of the cable by which the electric wire could be safely laid across the Atlantic, and I at once frankly communicated the result of my studies to the Chairman of the Atlantic Company. But in addition to the natural prejudice to unasked suggestions, there were so many direct and indirect interests involved in any reconsideration of the course which that Company had taken as to the envelope of their cable, that all I or my friends could say was of no avail.

In full view of the several serious mistakes that have been made, and the vast public importance of the subject, I at once abandoned every other pursuit, marked out a course, and have not for a day ceased to follow it.

Studies that have cost me much, I offered without charge, and at once secured, by patents, what had been refused, and sought the best interests in the cause at home and abroad; and an early audience of His Majesty the Emperor of the French secured me the support of both His Majesty and his Government.

Unhappily, the American war and consequent financial disturbances have delayed practical results; but the time has been exclusively devoted to the practical study of the different departments of the construction of deep sea cables, *their electrical, insulating,* and *protecting envelope,* as well as the *route* in which such cables should be laid across the Atlantic.

[These studies having been appreciated by the

Emperor and his Government, a concession has been secured, giving fifty years exclusive right to lay cables from France to America, with permission to the Company carrying out the work to issue bonds to the extent of £240,000, bearing interest at the rate of 4 per cent. per annum guaranteed by the Government of France; this amount is considered to be one-third of the entire capital of the Company, and is returnable out of profits of the Company in thirty years. The Government receives no share of profits, but pays for messages at the same rate as the public; with such privileges in our possession the public will learn with satisfaction that though lost cables have done much to damage the enterprising spirit of many philanthropic capitalists, the cause has not been on that account neglected, and the following sketch of studies may enlist greater numbers and additional ardour in the undertaking which promises so much for our common humanity.]

To make our studies clear, first of all let us glance at the direction a telegraph line should take across the Atlantic. This involves several important considerations that were entirely ignored by the Atlantic Company, whose cable stretched direct from Ireland to Newfoundland in the deepest water, when by going to the nearest point of the bank of Newfoundland, where there is only a depth of 100 fathoms, more than 350 miles of the distance between the two shores as to deep water would have thus been saved; moderate depths should always be reached as soon as

possible, because from them the cable can be readily lifted for any desired purpose.

We have not, however, presumed to make choice of any special route; that will be a matter for serious reflection, taking into account length of costly cable, and prospects of remuneration, besides the electrical considerations, all of which we are ready to lay before the council; but we may now call attention to some routes which seem to present considerable advantages.

If, for example, we take first of all the route from Brest to Cape Finister, a distance of, say, 380 miles; there is 320 miles of extreme deep water between these points.

From Cape Finister to the island of Terceira, the depths are extreme throughout, and the distance about 820 miles, making, from Brest, 1,140 miles of deep water out of 1,200 miles, which is about the distance from Brest to that island.

But to proceed from Brest to Terceira direct, the entire distance is about 1,140 miles; thus there would be a saving of about sixty miles of cable. But the extreme deep water would be less also by about 140 miles.

To proceed, then, from the island of Terceira, which we may remark in passing, is the most desirable on which to land the cable, not merely because the seat of government of the Azores is there, but the island is situated more in the direct route, and also in the track of ships from India, China, Africa, South America, &c., and they would be required by both

owners and merchants to telegraph, if possible, their arrival so far on their voyage, which would soon be, at a fair and adequate charge, a source of considerable revenue to the Company.

Now the distance from this island to the nearest point of the bank of Newfoundland is about 1,020 miles of deep water, and thence to St. Pierre Miquelon, about 360 miles, in depths of about 100 fathoms; thus the entire distance from Terceira to St. Pierre is about 1,380 miles, and the whole distance from Brest by this route to St. Pierre would be about 2,520 miles; and by way of Cape Finister 2,580 miles.

It is true that Cape Finister is half way to Gibraltar, but a single wire could not do both the American and Gibraltar electrical work. By this route we must not forget we include the inconvenience of passing through the territory of two foreign nations; first, Spain, and then Portugal.

Let us now glance at another route, which will involve a much greater distance from one point to another, but the entire distance from Brest to St. Pierre will be considerably reduced, and pass only through one foreign territory, viz., Ireland or Scilly, or both, if found desirable. By this route the distance from Brest would stand as follows, in three lengths:—

From Brest to Scilly, say		100 miles.
From Scilly to Ireland		140 miles.
From Ireland to the banks of Newfoundland	1,320	
Thence to St. Pierre in 100 fathoms deep.	420—	1,740 miles.
The gross distance		1,980 miles.

Thus there is a saving of about 540 miles of cable compared with the route by Cape Finister and the Island of Terceira. But then there is from Ireland to St. Pierre one unbroken line of wire 1,740 miles; this is electrically objectionable compared with the longest length, *via* Terceira, which is 1,380 miles.

Of the three routes, the balance of advantages in a commercial point of view seems to lie in favour of the route *via* Cape Finister and the Island of Terceira, although it would occupy so much more cable; and I think it will also turn out to be unobjectionable electrically. As we proceed we shall see it is very possible that by the advance of electrical science, means of telegraphing through even much longer lengths of submarine cable will soon be common enough, and in high or low latitudes alike as to practical working through the wire.

But there can be no question of the propriety of making the first ocean cable in the shortest possible lengths, that it may involve the least possible amount of risk, entirely regardless of international considerations, because a single wire can do but a very limited amount of the work that will be required of it from the vast and varied field of communication between two such continents as Europe and America. When several cables are successfully laid, it will be time enough to split straws about any international privileges there may be to secure. The present advantages to be gained lie in the liberal public support of

combined enterprise and science; both honour and commercial advantages will be sure to follow.

The above two examples of route may serve to show that our studies of this branch of the subject have not been neglected; but in speaking of the cable, we shall have to refer more especially to the depth of water in those routes. In concluding this part of the case, I should observe that by keeping the cable in about 100 fathoms when crossing the banks of Newfoundland, there will be no danger either of the anchors of fishermen, or of icebergs.

I propose now to speak of the cable as consisting of three distinct parts, each involving distinct natural laws; and by the combination of these three parts we shall have the desired electric cable specially applicable to ocean purposes, in contradistinction to the requirements of shallow water.

Firstly, the electric wire; secondly, the insulation of the wire; and, thirdly, the envelope by which the two first are carried safely to their place of duty.

First, then, the electric wire conductor, which in the desired quality has been no doubt studied profoundly, and leaves nothing for me to say, but that its conductibility should be in the most careful manner tested, and the test confirmed by the proper authority. But now we come to the most difficult point of the problem, namely, what shall be the size of the conductor?

Having watched with considerable care during the last six years the movements of professional elec-

tricians on this point, it is curious to see how perplexed they seem to be—like mariners at sea without a compass by which to steer; they treat electricity on no fixed principle, but each of these gentlemen has what he seems to call his own practical experience, and which differs so widely from each other, according to varied and inexplicable circumstances, that one is left to believe they are all of them in the dark as to the natural law by which electricity operates on the wire. One of those gentlemen, who stands high in the profession, seriously says "the "larger the conductor, the better. Will not a large "water pipe convey more water than a smaller one? "So, therefore, must a large electric conductor, on the "same principle, carry a larger amount of electricity!" The public generally have received this notion as true, and it seems to be held by the greater number of the most influential among them.

There is, however, another class of electricians who hold the conductor should be small; at least that it is not necessary to be of large dimensions. At the same time, they impress the public with the notion that whether the conductor is small or large, a current of electricity must pass through it.

But as speed of transmission is of the utmost consequence, it will be instructive to take a glance at a practical comparison of the working of two submerged cables. The Malta and Alexandria cable has a conductor of extremely large dimensions, and insulated better than any other cable yet made, at a cost of

about £300 per mile. One of the most talented and practical electricians, who had charge of the working of 500 miles of this cable, laid from Malta to the Tunis coast, distinctly states that with all the electrical ingenuity he could apply, only *eight* words per minute could be sent through the 500 miles of wire under his charge. And all the while, to his great annoyance, twelve or fourteen words per minute were sent through the Algiers and Toulon cable, also over 500 miles, the conductor of which was only one-third the size of the other, and the insulation of a very inferior character; but since then the Algiers line has ceased entirely to work.

With this indisputable fact before us, the Board of Management, by whom all matters will be finally determined, we may presume there will be no disposition to adopt a very large and expensive conductor.

This practical comparison seems to prove that electricians have treated electricity as passing in currents from one end of the conductor to the other, when all the while the working power of the wire may be produced by sympathetic effect, and not by currents at all but by a supply of electricity. The conductor being by its nature capable of receiving an electric charge, it follows that so long as it is kept charged—and this is said to be easily done if the insulation is perfect—the transmitting instrument, properly applied, would produce instantaneous effect at the distant end of the conductor, however small the wire may be. And it is not unreasonable

to suppose that if the conductor is large, the electric shock would not be so active and smart in its operation as on the one of moderate size.

Take for example the effect of polar attraction on a large heavy compass: however powerfully magnetised may be the needle, we find it moving in the most sluggish manner, when the moderate-sized compass is active, and always truly indicating any altered position of the ship's head, however sudden may be the change.

If, as the electrician supposes, the electric shock is conveyed in "currents," as it is expressed, how is it that any number of men, suppose a thousand, holding each other by the hand, will simultaneously receive the shock from the battery; though possible, it seems not at all likely that a current of electricity is so passed through such a number of men; but rather that the human system, which is known to be highly charged with electricity, is sympathetically affected by contact with the battery. And, by the same rule, there can be no doubt the charged electric wire, however small its dimensions may be, would, in like manner, receive the shock to its utmost extremity, provided it was perfectly insulated. This brings us to the second branch of our study, namely, the insulation of electric conductors.

Vast sums have been spent in the race after a perfect means of insulating electric conductors, and much public inquiry even under the direction of Government authority in England has been instituted;

but, unhappily, unless the results of such inquiries agree with the interests of the influential parties concerned, whose large investments are at stake, neither science nor the public are at once benefitted by the inquiry.

My efforts, however, in this branch of our subject have been unceasing, and, I may add, very costly; but at this moment I can assert with considerable confidence that I have succeeded not only in producing an insulation the most perfect and desirable, but also economical as to cost, and easy as well as simple in its manufacture. I feel, therefore, perfectly warranted in the belief that this result of our studies will render—along with the others—Ocean Telegraphy of easy and safe accomplishment.

We produce this result by means of india rubber, worked in a new and easy manner; at the same time it is preserved infallibly from all the injurious effects, which, by other means of using india rubber, have been most objectionable.

By our system it so fastens on to the conductor that induction, absorption, or escape of electricity is reduced to its minimum amount, whilst the temperature, however low, does not in the least degree injure it; and if it is increased to 300 degrees of Fahrenheit, the insulation is improved rather than any contrary effect being produced; and it possesses at the same time all the qualities necessary for splicing with great facility on board ship.

Inquiry and proofs of the most searching kind have

shown that india rubber surpasses every other material for perfection of insulation; the difficulty lay in its manufacture, which, I believe, is now fully overcome.

I have no manufacturing or commercial interest to serve; our research has been purely and exclusively on behalf of the cause of Ocean Telegraphy, and when the Board of Management makes its selection of insulation, my labours will, no doubt, have fair value put on them.

I might proceed to compare gutta percha with india rubber as an insulator; but the one fact that a temperature of about 90 degrees Farhenheit will soften, and, I may add, practically destroy gutta-percha for Ocean purposes, unless kept in water tanks on board ship, which is not only costly, but dangerous, and altogether unnecessary, when a better means is at hand, as above described.

Thirdly, the *envelope* by which the electric wire and its insulation are protected and carried safely to their place of duty.

It will be admitted on all hands that the electrician may perfectly prepare the conductor and insulate it without a fault, *in vain*, unless an envelope of the right kind is provided, by which it can be safely submerged in the greatest depths of the ocean; not only in fine weather—in this there may be but little difficulty, of whatever kind may be the envelope—but in stormy weather, which must be provided for in crossing the Atlantic, when the character of the envelope is of para-

mount importance. Now, if the envelope is made of iron in any shape, its specific gravity is so great, or, in other words, its weight in water is so extreme, that in such depths as we find in the Atlantic, the weight of the iron-covered cable would be more than its strength could bear with safety to the electric conductor.

It is true that so long as the ship is progressing rapidly the cable would run out in an oblique direction with but little tension upon it; but there may be many incidental causes in making the long voyage across the Atlantic that would require the ship to be stopped; the cable would thus become vertical, and when once in that position, its immense weight would be too much for it to bear, and it would increase its momentum with every surge of the ship, and become uncontrollable; even in fine weather, under such circumstances, it would be lost.

A simple but strong well manufactured hemp rope, properly preserved—of which I shall speak presently—is the only known material at all suitable to the performance of this duty. Its natural characteristic is to contract when saturated with water; this quality alone is an invaluable protection to the electric wire, for by the natural shrinking of the hemp it takes the tension that would otherwise come upon the electric conductor; but the metal not being subject to the contracting effects of contact with water, it has none of the tension to bear; hence it is, of course, protected.

Many objections have been offered to the use of

hemp for such cables; but as the last six years have worn them all away, I need not enumerate them; some of them, indeed, equally applied to wire. If, for example, there should be any abrading cause at the bottom of the ocean, which sound philosophy does not for a moment admit, but supposing it to be true, it would, in a few days or weeks, destroy an iron cable as well as that of hemp.

But on the ground of the naturally delicate character of hemp, there was good reason to question its suitability for the purpose, not because of its being subject to decay when once submerged, but months or years might elapse between the time of its manufacture and its submersion; during this period, or even in a week or two, lies the danger of decay which no tarry substance could entirely prevent, however well it may be applied.

It was, therefore, necessary to devise, if possible, a means by which hemp could be effectually preserved; and, by many laborious experiments and much expense, I am happy to say the difficulty has been completely overcome; and I have fibrous substances, hemp, &c., prepared by a simple chemical solution that have been exposed to the corrupting effects of destructive matter, animal and vegetable, for the last six years, and it still remains as sound as the day it was made, though the unprepared material of the same kind was destroyed in three or four weeks' exposure to the same corrupting matter. Thus, again, our studies are of incalculable value. On each of these topics we

could considerably amplify, it will be readily conceded, after so many years incessant study of the subject.

Many of the lost cables, for example, might thus be readily accounted for, but their loss may always be reflected upon with advantage to the future. Each of them supply some confirmation of the correctness of the conclusions to which we have arrived, and the most recent operations of this kind, especially one which I must forbear to mention here, though the result of it is another conclusive proof of the necessity of hemp cables for laying in deep water, and ought to change the electrician's views on the subject. At the approaching moment when the important selection of the ocean cable will be made, we shall be prepared still further to extend the light we have acquired on each branch of the subject, for the use of those entrusted with such important selection. We have yet, however, another department of study on which to say a few words.

All of us are more or less familiar with the sea's surface, and the necessity of practical seamanship to navigate over it, especially during a storm; and if the seaman has command of the ship he must of necessity have command also of the cable that is being submerged; there can be no division of command in this case, without serious danger to the operation. And if the operation is to be under the control of a nautical commander, he must of necessity have a voice in the selection of the cable, for the safe laying of which he has to be held responsible.

With this practical necessity of the case clearly before us, we should take care to provide the best possible nautical element on every board of management.

It may be here observed that in none of the companies whose cables are lost has there been any responsible nautical department. Engineers have unhappily obtained the contracts for making and laying the cables at a fixed price, and therefore have taken entire control of the operation; for this grave error both engineering science and the public have dearly paid—the first in loss of reputation for so presumptously undertaking to solve the nautical problem of laying cables across the ocean, and the public have suffered in both cash and time, the money value of the latter being incalulable.

The British public, however, is the wiser for such costly experience, and is, we hope, no longer disposed to trust engineers with the charge of such nautical affairs.

Now, with reference to another important point of our subject, viz., the management of the shore ends of a cable,—we find from the best possible proofs that are indisputable and conclusive, that below the tidal wave on our coast, even during the severest storm—when the sea runs so high—there is only some twenty or thirty feet of disturbed water, and, in most cases, if a cable is buried some three feet in the beach, which is easily done, so far as the low tide will admit, it is not very difficult to continue its subsoil

position by means of a diving bell to some desirable distance from the shore.

This being done at a well-chosen landing place, many of the annoying interruptions to which cables are now subjected would be avoided, for they obviously arise from the sea rolling in upon the exposed cable.

But though we have carefully studied the tidal and other shallow water effects on the cable, they are secondary to our main object, because the cable is within reach of early and easy repairs. Let us now, therefore, take a view of our difficulties in the ocean where there is no tidal wave, but waters moving by other natural laws by the name of currents which are supposed to be dangerous, but on sound philosophical inquiry we find the imaginary currents are infinitely more dangerous than the real ones. To illustrate this truth I may mention an incident in my own experience. Having once met an American vessel in the Atlantic, on her way from that continent to the Mediterranean, labouring under an error in his longitude of over 300 miles, having no chronometer to guide him, he had made a daily allowance for the Gulf Stream, which did not exist but in his imagination, and which at once accounted for his error. A still more striking and serious case occurred with the engineer in charge of laying the Atlantic cable. Under an impression that a current was carrying away his cable at the first attempt to lay it, he applied restraint, so severe, indeed, that the cable broke, and he lost nearly 400 miles of valuable cable, besides

spoiling the operation otherwise. There was, in fact, no current at all, but the iron cable was so heavy that its rapid departure from the ship could not be controlled. But he erroneously attributed it, in his official report to the Atlantic board, to current.

I need not enlarge on this important part of our subject here; a chapter on the currents of the ocean reduced to the simplest rules of science, must speak for itself; from this cause, however, we shall have no danger in the laying of a cable.

It may now be desirable to speak of the bed of the ocean on which the electric cable has to be laid. To reach this bed, over much of the distance it has to pass through a depth, we will suppose, of some 5000 yards, and the impenetrable darkness by which it is hidden cannot have much practical light thrown upon it by merely touching the bottom by means of a sounding lead, nor can the depth, however correctly ascertained, or the infinitesimal sample of the bottom brought up inform us much about the inequalities or senuosities of its formation. And the insignificant number of soundings made, compared with the vast expanse over which they are dotted, and these coupled with the difficulty of navigating within a few miles of any special line, at once present to the mind how hopeless is the task of ever becoming familiarly acquainted with the hidden depths of the ocean.

It is true we have had pictured to us the undulations of the ocean's bed, as if the surveyor had walked over it and carefully noted the minutest gradients.

But we must not forget the entire portrait is purely imaginary, the artist had only a few depths of water indicated on the chart, and with a copious imagination the rest was easily sketched.

Long laborious studies, however, of this branch of this subject, lead us inevitably to such conclusions as render unnecessary any further prosecution of the costly and interminable "survey," as it is termed, of the depths of the ocean, save that it is well to know, if possible, the actual or approximate depths of water everywhere. By microscopic examination of the matter, invariably brought up from extreme depths, however, we learn that it mostly consists of a very minute shelly substance, which has been generated at the surface, and after death, their body being heavier than water, has sunk to the bottom, which leaves no doubt that both in the tropical and temperate latitudes where the sun has considerable power, there is a perpetual shower of such matter falling from the sea's surface to its bottom, to say nothing of still more minute inhabitants of the deep that lie there.

It is no great stretch of the imagination then, to conclude that as this process in nature has been going on ever since the day of creation, the original character of the great deep, however rugged, sharp, and pointed its formation was then, is now deeply covered by this matter, which forms a soft and suitable bed on which the most delicately formed telegraph cable would lie safely.

We do know, moreover, by countless conclusive

proofs, that the water at extreme depths is perfectly tranquil, that no abrading cause exists there. Also that inasmuch as the heaviest water must naturally lie at the bottom, and that it is heavier because it is salter than that at the surface, however slight may be the degree of difference, it follows that as the salter the water the more preserving it is of fibrous, whilst it is the more destructive of metallic substances, the balance even in this particular, also, is in favour of hemp cables. Again, if there should be abrupt and deep undulations, over which the cable should chance to pass and be suspended between two elevations widely apart, a metallic cable might break by its own ponderous weight, whilst the light hemp one would rest securely without injury to its electrical integrity. But our means of meeting the possibility of passing such severe submarine undulations is by paying out a given amount of extra cable over the speed of the ship that is laying it, such as may be in the judgment of the board of management determined upon, to meet the unknown senuosities of the bottom. A light hemp cable is easily controlled for the fulfilment of this very important point, but a metallic one is simply uncontrollable.

A word with regard to the extreme depth of the Atlantic may serve to bring the hempen cable into still more prominent contrast and favour for the work. It is often asked what practical proofs have you that hempen cables will be the best? We might answer, with emphatic truth, that iron cables in all conditions

have been proved to be incapable of bearing even their own specific weight, to say nothing of their corroding and other objectionable qualities, which render them for ocean purposes utterly unfit.

All the scientific nautical gentlemen who have sounded in the greatest depths of the Atlantic, have done this, not with steel or iron, but with hempen lines; and in countless instances, besides ascertaining the depth of water, have brought not only the line itself, but a ponderous sounding lead also again to the surface in a depth of 5000 yards and more. We are, in fact, indebted to the hemp line for all that we know of the bed of the ocean, and we maintain the hempen telegraph cable is only an extended size of the sounding line, and fully entitled to all the merits of its practical working. The proof, therefore, is conclusive, that hemp is strong enough to bear the tension, and light enough to be under the most perfect control during the performance of this important duty. Better and more extensive proofs of its complete suitability could not within the bounds of reason be desired; to assert these are not substantial proofs of its superiority over every other material would be to say what was simply untrue.

I need not here enter upon the vexed question of pressure and column weight of water at extreme depths. It is enough for our present purpose to know that the hemp sounding line did not suffer by the pressure, nor did the column weight of water prevent it bringing the lead with

its charge of geological matter safely to the surface.

On this branch of natural science, I may observe, our research warrants me in making the strongest assurances, that neither the insulation or the electric conductor will be in the least degree injured by either the pressure or weight of water, or be subject to more inconvenience than the sounding line has been.

On each of the points noticed we could enlarge with practical advantage. But it will be admitted from what has been said, that we have devotedly studied the subject of Ocean Telegraphy, and have ample grounds for confidently assuming that with due care our prospects of laying a cable successfully across the Atlantic are based upon the soundest common sense, and supported by the most enlightened philosophy. Under the guidance, therefore, of such eminently practical and independent gentlemen as those which form the Ocean Telegraph Board of Management, both Europe and America may now look with confidence for the early and sucessful solution of this great problem.

Paris, 9th February, 1864.

On the return of the *Bulldog*, I addressed the following letter to the Editor of a leading Metropolitan Journal, and sent a copy of it to Captain Sir Leopold McClintock. It did not, however, appear in

print; but many of my friends, who desired me to make some remarks on that gentleman's report of his survey, may now see that I was not inattentive to their request, as to what then appeared to me likely to serve the great cause of the Ocean Telegraph:—

Paris, 14th December, 1860.

Sir,—The surveying voyage just completed by Capt. Sir L. McClintock, in H.M. steamer, *Bulldog*, affords a fresh opportunity for discussion on the important subject of Ocean Telegraphy. But, in venturing a few remarks on the subject, it must not be understood that I offer any opinion on the propriety of landing telegraph cables on the ice bound shores, or their safety across the land in northern regions. I must leave these two subjects for others to clear up, and no one will be more pleased than myself to see them settled satisfactorily to the interests both of the cause and of those gentlemen who have so laudably exerted themselves in the enterprise. There is ample work for many telegraph lines between Europe and America, and why should there not be several routes for them?

Captain McClintock draws a somewhat dreary picture of the coast on which the cable is proposed to be laid. He passes sometimes within twenty-five miles, sometimes about forty miles from the shore, the accumulated ice preventing him from approaching nearer; yet when he finds a spot for landing the cable on the most sheltered part of the coast, he says, "Either fend

"off the floating ice by means of the chains secured
"across, or build up the fissures with stone and
"cement, so as to afford the cable within it undoubted
"security."

But shareholders do not relish the cost of such structures in a region that for several months in the year is unapproachable for repairing any damage that may happen. If this is the best landing for a telegraph cable there, we fear the labour has been in vain. Captain McClintock lays much stress upon the unusual severity of the season, but he only speaks of October and the first few days of November; after that period even a still greater severity of winter is to be expected.

There are other features of his report which for the sake of the science of Ocean Telegraphy must not be overlooked.

The result of the three months arduous duties of survey will of course soon appear in the shape of a map, like others of its kind, and in which useful facts will likely give place to imaginary representations, bearing the appearance of a land survey, a few spots being touched here and there in the dark over the bed of the ocean, and in reality nothing more, however glowing may be the description. We may presume that Captain McClintock has taken deep soundings at fifty different spots during his cruise, and the latitude and longitude of each is laid down to a mile or two, the depth true to a few fathoms; the bottom has been brought up, and geologists have

named and classified its several components. From these meagre particulars we are assumed to be as familiar with the ground as if Sir L. McClintock and his companions had walked deliberately over it. The scientific inquirer claims the faculty of lighting up all this abyss of darkness, if he can only with his magic lead and line touch the bottom; and it is indeed marvellous to see with what interest credulous believers will listen to the story, and scan over the future map which is to make them acquainted with the precise spot on which the cable should lie—a map so precise in its details that it would seem there was no sort of difficulty even to let down some soft rests for the cable to lie upon. But the nautical profession should frankly own and non-professional men should clearly understand how impossible it is for any navigator, however perfect he may be, to count on sailing twice on the same line across the ocean. Not, however, because the current may carry him during thick weather away in some uncertain direction, for currents only exist on the surface, and in the broad ocean are seldom or ever deep enough or strong enough to affect seriously the ship's navigation, unless indeed the vessel is very small and skimming on the surface.

The real difficulty lies in the uncertainty of steering by compass, there may be a careless seaman at the helm—a compass that moves heavily on the needle or one that is incorrectly adjusted; another compass may be correct when the ship is steering in one course

but considerably wrong when steering in another; and it does not unfrequently happen that local and accidental circumstances create serious divergences in the compass. A sailor inadvertently and unobserved, may have his knife or his marlingspike near the compass for hours during the day, causing an unobserved error of a point or two. I have often practically detected each of these causes, which, however, are seldom admitted; the officer of the watch, for his own credit, will insist on the course having been correctly made and the distance by log correctly allowed, and therefore whatever error—sometimes amounting to 5, 10, or even 20 miles—may appear in the ship's reckoning at noon, when the sun has indicated her precise position, all is put down at once to current, as the most convenient way of squaring the dead reckoning; such is the general and undefined notion of currents entertained by seamen generally, and hence the difficulty of such precise navigation over the ocean as landsmen imagine it to be. The ship might be miles on one side or other of her direct or intended course, and the divergence might not be detected, even in fine weather, though the difference of a quarter of a point in the course—and this a very small margin—will produce an error of over 15 miles, right or left of any given line in a distance of 300 miles. Polar navigation is still more embarrassing, from the extreme variations of the compass, which renders it impracticable to steer exactly upon any given line, as every navigator of that region knows.

What then can be the use of all this precise sounding to the cause of Ocean Telegraphy; when it is all but impossible to sound within a mile or two of the same spot twice? It is I repeat, a mere feel here and there, in the dark, at best, producing only the few specks of sand, shells, and other deposits brought up, which, though interesting no doubt geologically, it is doubtful whether such chance information can supply any logical reasoning, or whether it may not tend rather to confuse than improve our knowledge of the laws by which that science is professedly governed.

The admiralty no doubt considered the survey in the light of a scientific enquiry; by such geographical research, dangers to navigation might be discovered; a knowledge of the general depth of the ocean increased, and to a certain limited extent, it may be admitted that the information is valuable. The government wisely determined that the public ardour for laying a wire across the Atlantic, which had been so rudely checked, should be so far encouraged.

Expensive submarine surveys for Telegraph purposes over a sea, which for so many months of the year is so utterly impracticable, naturally remind us of former surveys across the Atlantic, in the Red Sea, and in the Indian Ocean; and after all the labour and cost of these, what became of the cables professedly laid over the surveyed ground? Their lamentable silence however is no proof one way or other as to the character of the survey. Happily, success in Ocean Telegraphy depends not upon such labours: if

it did, as perfect a survey as possible should be made. But it should be frankly admitted, that no one can rely on laying the cable within some miles of the spot that has been sounded. If in extreme depths dangers exist at all, they are not to be discovered by such operations: we are bound to declare that over a field so vast and so dark, examination is simply impossible; a cast of the lead here and there, some 50, or 30, or 20 miles apart, even in two parallel lines, though giving the general depth of the water, could convey no adequate notion of the actual undulations or character of the ground over which a Telegraph wire must pass. It is then clear that the object of any survey of the bed of the Ocean, must be confined to its *approximate depth* and geological character, judging from the few mere scraps that may be brought up from the bottom.

The depth has doubtless been a serious consideration of those gentlemen who have so determinedly insisted on the use of iron or steel wire for the envelope of the cable; but such cables are only suitable for, and can only be safely laid in shallow water, simply because of their great weight. A cable, for example, that would only weigh 20 lbs., in the 20 fathoms depth of water between Dover and Calais, must by the same rule be 2000 lbs. weight, in 2000 fathoms depth of the Ocean, where it is often much deeper, and the cable proportionably heavier. We are not left to speculate as to whether such ponderous weight can be controlled in its departure from the ship; because the

engineer reported to the Atlantic Company, and his report was endorsed and published by the high authority of their board.

"That the cable was running from the ship at five "and three-quarters knots per hour, whilst the ship "was going only three knots through the water, to "prevent this waste of cable he increased the "restraining force of his paying out machinery by "slow degrees up to thirty-five cwt., and the cable "broke when three hundred and eighty miles had "run out," and was of course lost.

The remedy for this palpable mistake it is clear is not in seeking shallow water, for this cannot be had either in the broad Alantic or the Northern Ocean, where it has been so earnestly sought, and where the discovery of a depth of a few hundred fathoms less than expected, has been so highly prized. But surely there is another means of getting over the difficulty. If the mountain cannot go to Mahomet, Mahomet can go to the mountain.

It is easy to reduce the specific gravity of the cable so that instead of loading it with a weight of iron to break it, a simple combination of hemp may be used; some kinds of hemp will even float, but none are very heavy in water, a cable or envelope can be made entirely of fibre, and possess many valuable qualities besides its peculiar adaptation to the deep waters of the ocean. Its specific gravity can be so reduced that instead of a cable weighing thirty-five cwts., as above, its weight in two thousand fathoms

could be adjusted to five cwt., or in fact to any desired figure. Why then should iron or steel be used, seeing that at increased depths it becomes so uncontrollable and dangerous to the integrity of the electric wire, even in what is termed moderate depths? Besides it is always subject to rapid corrosion, whilst hemp in its simplest form is most durable, being capable of holding in combination with itself that which renders it indistructible, even by animalculæ of the vilest kind. It is not my object to enlarge upon these undeniable facts, though the more they are examined the clearer will appear their invaluable merits; merits which furnish the most powerful answer to the seekers after the shallow waters, through which they contemplate encircling the globe with electric wires.

Another important point with reference to extreme depth of water must not be overlooked.

Dr. G. C. Wallich, F.S.L., who undertook the duties of naturalist during the late trip of the *Bulldog*, speaks of—"The animal life of high organization "found on the sounding-line which had been on the "ground in 1,260 fathoms, a depth of two miles "below the surface, wherewith pressure must "amount to at least a ton and a half on the square "inch, where it is difficult to believe that the most "attenuated ray of light can penetrate, we find a "highly organized species of radiate animals, living "and evidently flourishing."

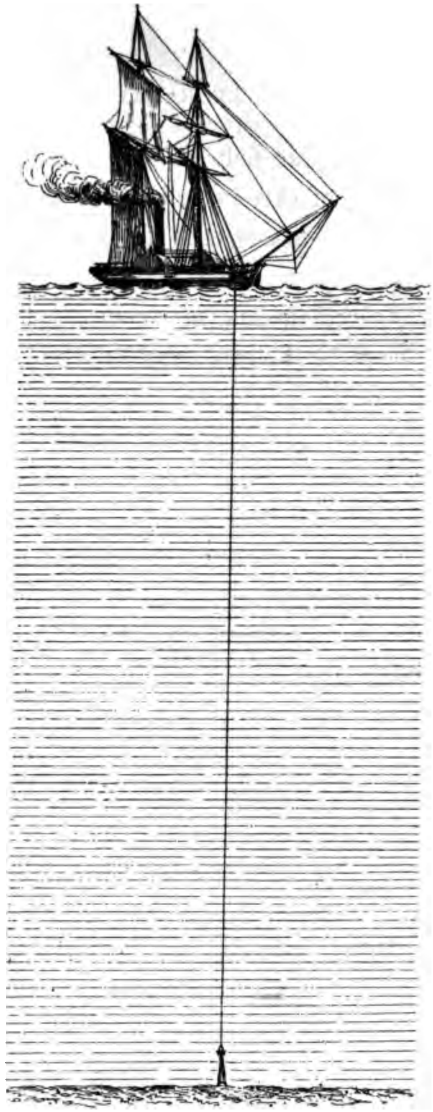
The Doctor is, I dare say, aware that living

animals have been drawn up from much greater depths, but he has not perhaps valued the information which the fact conveys, and as it involves a serious consideration in the science of Ocean Telegraphy, he will pardon my making special reference to his statement.

I have no doubt he religiously holds the belief that such pressure as he states of 30 cwt. to the square inch actually existed, though the only reason he could assign for the belief is that he was taught the doctrine in youth, that it has grown up with him, and as the science of Ocean Telegraphy is only new, he has had no occasion to unlearn the belief, or even to enquire particularly as to its foundation. Nothing in nature could be more evident or clear than that the little star fish he describes brought up from a depth of 1260 fathoms, could not possibly bear the weight, he says, "must have rested upon it."

But on reflection, I dare say, he will admit that water is incompressible, and that though all substances gravitate towards the centre, and by that law of nature taken alone he could fairly draw the conclusion he has put on record; yet, as in chemistry so in other sciences, there are counteracting agencies, and if he takes into account the earth's centrifugal motion by which the pressure towards the centre is thrown off or reduced to a mere balance in favour of gravitation, he will perceive how the great ocean basin holds its mighty contents without allowing them to press so enormously, and, I may add, unnaturally,

Plate 2.



Report of the Sounding Voyage of
H.M.Ship, "Buldog", in 1860 (page 12) — Captⁿ Sir F. Leopold Mᶜ Clintock.
Published by order of the Lords Commissioners of the Admiralty.

"The Cod Line of Messʳˢ Newall has answered admirably. On one occasion IT "BROUGHT UP THE IRON SINKER OF 118 lbs. WEIGHT FROM A DEPTH OF 1913 FATHOMS."

"The tiny size of the Cod Line will be better understood by the following comparative "weights.

Cod Line by Messʳˢ Newall, weight per 100 fathoms	4 lbs. 5 oz.
Ordinary deep sea (sounding) line, weight per 100 fathoms	22 ½ lbs.

upon the tiny little star fish he had described. The supposed enormity of this imaginary pressure has had much to do with the losses that have been sustained in Ocean Telegraphy, as I have on several occasions endeavoured to explain, as, for instance, in my letter to the *Daily News*, of the 9th October, 1858, in answer to their Valentia correspondent. But Dr. Wallich could not have a more complete illustration of the fallacy of the extreme column weight of water, than from Sir L. McClintock himself, who says in his report:

"The tapered whale lines were indispensable, and "the contract cod line has answered admirably; on "one occasion it brought up the iron sinker of "118lbs. weight from a depth of 1913 fathoms."*

This clearly shows there is no column weight, as we have been taught, sufficient to keep down the sinker, nor lateral pressure strong enough to press or jam it. Had there been either, the tiny cod line would not have drawn up itself or the sinker, the bare weight of which out of water was so near its capabilities of tension. But according to the worthy doctor's own statement, a living proof of the fallacy is produced, as if these little creatures had come up on purpose to reveal a great truth, not one or two of them, but in great numbers, telling the same story, singing the same song: "The wisdom of man is "foolishness with God." See, therefore, and learn ye wise men of the earth, there is no pressure where we came from to injure either us or your telegraph

* See plate, No. 2.

cable, lay it quickly, and let peace and goodwill be flashed by the electric road from one nation to another.

These little truth-telling creatures with one voice, as plain as they could speak, delivered this touching message. Yet the doctor persists in asserting that the pressure of water at 1260 fathoms, is "one ton "and a half on the square inch."

There are other errors we have been guilty of, in this science, one of which is of such importance that it would extend my letter too much to enter at large upon it. Permit me, however, to say a word or two on the subject of distance from shore to shore, which is a grave question in Ocean Telegraphy.

Electrecians seem to assert that extreme distance is no bar to the passage of electricity, provided the channel is otherwise clear; nevertheless we may take this statement in a limited and qualified sense. But if it be true, where is the use of hunting the frozen shores of Iceland and Greenland for a clear spot on which to land a cable safely, merely to save the distance of a few miles from one point to another across the ocean, when all the while the problem of distance, at least to the extent of 2000 miles, was solved by the Atlantic Company, with one of the most imperfect cables ever made, laid in a sea of the greatest depth, and through which, over an extent of 2000 miles, more than two words per minute were transmitted.

What could possibly prove more plainly that nothing is wanted but a properly protected, unbroken line through which the electric shock can speak, or the sym-

pathetic shock be felt? Neither extreme distance nor depth of water can be said to be obstructions to the most perfect success of the enterprise. Nothing can be clearer than this: that a cable suitable to the necessities of deep water, such as I have described above, and proper landing places for each end of it are all that is required. As to the cable; we have seen that one, as much as possible like the sounding lines described so graphically as a whale line and cod line, and so unwittingly recommended by Captain Sir L. McClintock, would not only go to the bottom quickly, but can be brought safely back again, if need be, and this is an operation with which the electric wire in its centre would not injuriously interfere.

Judging from experience, the conclusion is forced upon us, that whilst iron in any shape employed for such cable, is subject to the destructive chemical action of sea water, the whale line has lain for sixty years, both in the *Republic*, French ship of war, that sunk off Brest in 1790, and the *Royal George*, at Spithead, and after a lapse of so many years their ropes were found uninjured, though lying among star fish and many other creeping things of the sea; hemp was evidently not a palatable food for them, even in its natural condition, but how much less so, when the fibre is prepared so that no kind of animalculæ can touch it, even the most destructive of them, as many years tests have proved.

I may conclude by expressing my sincere admiration of the enduring perseverance of Captain Young

and his companions, during the arduous exploring voyage he has just completed in the Fox; no less than for that of Captain Sir L. McClintock, and his companions; their labours have been, doubtless, most meritorious whatever may be their future use.

As the landing of a cable in safety, seems to be the only point nautically required to be solved by these excellent navigators, it would have been satisfactory to find how Captain Young arrived at his conclusions, with respect to the "fiord called Tgalika." He says he proceeded to the "examination of a deep and "romantic fiord called Tgalika Fiord, into which "large icebergs never enter, and in the channel of "which sufficient water was found effectually to pre- "vent the grounding of the largest ever seen."

One would naturally like to know how, during the long and severe winter of that locality, a conclusion so vastly important, can be arrived at; for, when ice sweeps along the coast, impelled by the stormy winds, so evidently prevalent there, it seems difficult to conceive a limit to the danger, because it is impossible to tell what direction, or what freaks, large masses of ice will take.

If these remarks, Mr. Editor, will elicit from my brother seamen, more practical expressions of thought on this new branch of nautical science—into which it seems to me impossible for any man to enter usefully, or with the necessary practical force, till he can, like these two excellent representatives of the profession, Captain Sir L. McClintock and Captain Allen Young,

boldly face and master the stormy difficulties, which are so inseparable from their profession, but utterly unknown to any other,—my object will be gained. And, by the insertion of this letter in your journal, you may do some service to the cause of Ocean Telegraphy.

I have the honor to remain,—Sir,

Your most obedient Servant,

W. ROWETT.

"Paris, 23rd June, 1863.

The time has arrived when the subject of placing a telegraph cable across the Atlantic may, with advantage, be again discussed. I, therefore, beg permission to suggest a principle to which all the experience we have obtained from experiments such as the Atlantic, Red Sea, and the "Falmouth Gibraltar" cable, which are of the most costly character, unmistakably point.

It is said the teaching of all social principles is that every man should mind his own business. Practical architects are not practical surgeons or chemists in the world's estimation.

Sailors are no more electricians than electricians are sailors; and when the one assumes or interferes with the business of the other, the golden rule, and what should be the ruling principle in every department of life, is not only violated, but incalculable damage is done to science, to society, and to the State.

It will be admitted that the great work of preparing and laying telegraph cables safely across the Atlantic involves at least *two branches of science*, viz.: the electrical and the nautical. But as they cannot be always in operation at the same time, it will be well to see clearly where their limits are; when and where the electrician's duties begin and end, lest he should be charged with responsibilities that are foreign to his profession; and where the nautical man's duties take their start, and where they terminate; lest he also should be charged with what does not belong to his department.

A careful and practical Board of Management will assign to each their work, and keep both parties within the proper limits of their respective undertakings when they are once defined.

It will, perhaps, be said, surely the electrical engineers by this time, with all their past experience, have learnt their duties in every department. The most liberal and wealthy men in the country have innocently fallen into this erroneous belief, under some vague and undefined notion that Ocean Telegraphy could not differ much from the science of that on land.

They never consider that when a cable is started from one shore, it must proceed without stop to the other, night and day, during the violent storm or fine weather alike. This operation, therefore, differs widely from running a line over the land where the work is suspended during the night; and if the day itself is

stormy, it is at the engineer's option whether he proceeds with the work or not.

Hence the necessity for a good and practical seaman to take charge of both ship and cable, that during the operation of laying, there should be as perfect a control over it as the circumstances of a dark stormy night will admit.

If the distance from shore to shore is short, a fine day or two could be chosen for the operation, and a landsman might do it; but in crossing the Atlantic, the distance is so great that dark nights must intervene, and who can tell whether they may not be boisterous. Hence, the necessity of providing against them, and this can only be done by the application of seamanship to take the necessary care of the cable. It clearly follows there must be nautical approval of the kind of cable to be so cared for.

It is true that after the loss of the Atlantic Cable some nautical gentlemen were called in, to approve the character and construction of it. And it is equally true that they, from the mere glance at the subject, after no special study of it, and under some vague impression as to the requirements of the electrical mysteries involved, and, no doubt, partly from a delicate sympathy for the parties who were then labouring under a loss so severe, gave a faint approval of the cable that had been adopted. But the public was not blind to the fact that the advice of these gentlemen should have been taken before, and not after the cable was lost, or, in fact, before it was laid,

or before its character had been at all determined; they would then have taken time to reflect, and seriously determine what the construction of the cable should be, when a professional responsibility had been laid upon them; but to call them in to relieve the responsible parties of some of the odium which was then keenly felt in the public mind, was not only an unmistakable admission that they ought to have been consulted at the outset, but something like an insult to the nautical profession, when taken in conjunction with what immediately followed. Do we find the nautical element in this great problem put into the place so tacitly admitted it should occupy? Not at all! A commission was appointed by the Board of Trade to enquire into and settle the problem of Ocean Telegraphy, and the Atlantic Company was honoured with several seats on that board. And after all the past experience, strange to say, it was not by either party considered expedient that any nautical gentleman should share the responsibilities of the commission; and even in the prolonged inquiry, evidence of the nautical profession was almost entirely ignored, though a period of two years was occupied, during which the commission was frequently and urgently appealed to for the appointment of a nautical gentleman to assist them.

And will the public now permit any further such encroachment on the rights of science without a word of comment?

Will those entrusted with the charge of laying

Ocean cables continue to defy the nautical science, or will they determine that no man shall be called to perform any other duties but those of his profession?

It seems hardly necessary we should add another word to induce a public demand for the application of such sound, common principles to this matter, when the honor, as well as the interest of England is so deeply involved.

The "Ocean Telegraph Company," as well as the Atlantic Company, who are now moving in the enterprise, will do well to mark that a just sense of the duties they have undertaken will no longer admit of special consideration for any individual interest, whether of a manufacturing or financial character.

And to simplify the work, we shall be pardoned for presuming to suggest the defined limits of duty to each of the two branches of science involved in the work of *Ocean Telegraphy.*

First.—The electrician, we presume, selects the best wire for the electric conductor, which he proves by the best known tests. And the choice of insulation for the conductor is also in his department; the perfection of this cover of the wire it is impossible to prove in all its electrical departments, unless it is submerged to a proper depth, and for a sufficient period of time. But when this has been done to his own satisfaction, *and* that of the Board of Management, his duties and his responsibilities for the time essentially cease, because the insulated wire has then to be prepared with the necessary cover for sub-

merging it safely; and the electrical duties can only be resumed when the cable is thus made complete; he will then again proceed to detect faults, if any have been made in the process of covering the conductor, or from any other cause, for which his constant tests electrically, will of course, be necessary.

Secondly.—The authorised nautical department then receives the insulated conductor in a certified condition of conductive power under its special care, and from that moment it must of necessity be held responsible for its safety. This duty is obviously to see it safely and efficiently covered in strict accordance with the plan determined and laid down by the Board of Directors, and of which the nautical department has approved as the best method of covering the cable for being submerged with safety in such deep waters as that of the Atlantic, during a storm; when it is prepared for a storm, there can be no doubt of its efficiency for fine weather.

As this is being done, the cable in its complete state should be again well submerged, and tested electrically. Whatever defect now presents itself may be attributed to the nautical charge, and when such defects are adjusted satisfactorily, the cable may be coiled for good into the ship clear for paying out. During this operation, the electrician will, of course, transmit messages through the conductor, and a perfect record of them be kept for the satisfaction of the Board—thus the least defect will at the earliest moment be detected. But this does not imply the

least necessity for the electrician to assume responsibility in coiling the cable, for which the best nautical skill must, essentially and alone, be held responsible. On this depends the clear running of the cable from the ship, and in stormy weather I repeat, for which the most careful provision must be made, and to which the most skilful attention of the best nautical men is of the greatest importance.

No greater mistake could be committed in Ocean Telegraphy than to permit for one moment any landsman to have charge either of coiling or laying the cable. It would be equally consistent for him to take command of the ship, and we need not inquire how dangerous thut assumption would be.

Landsmen are generally under the impression that the mere matter of making and coiling a cable is a very simple mechanical operation, which any ropemaker at least can perform.

This is another mistake to be noted, for even ropemakers are ignorant of coiling ropes; that part of their craft is done by circular motion given to a reel on which the rope is given the neat coil in which we are accustomed to see it. In the whale fishery, the line, being fast to a fish, is carried at great speed from the boat; but it is carefully coiled by the most practised seaman, under the inspection of a responsible officer. The importance of these practical points are likely to be overlooked, because it is impossible for them to be properly estimated by landsmen.

It is, then, obvious and clear, that though the

electrician must in no way be interfered with in pursuing his electrical duties, it is the nautical man alone who can undertake the care of the cable when it is electrically prepared, and who alone can be held responsible for its being safely submerged. It is he only who can be supposed to know practically the effect of *tides*, *currents*, the *mountain wave*, and the violent complex motion of the ship, upon the cable that is running into the deep ocean. To regulate the operation on any other belief, would, we submit, be the grossest violation of scientific principles. Let us look to electricians for improvement in electric conductors and insulations, and to the engineer for every description of mechanical appliances, and the construction of the ship itself if you will. But when they have done their utmost, the ship must be handed over to a seaman to clothe, or suitably rig and sail, for which the builder is not held responsible, and in like manner let the insulated electric wire be handed over to the efficient nautical man to clothe or suitably prepare, and then to submerge it, for which the electrician cannot, in justice or reason, be held responsible.

When the duties and responsibilities so inseparable from Ocean Telegraphy are thus defined, and in good faith carried out by an independent Board of Management, the great problem will be easily solved, and rapidly developed, to the perfect satisfaction of every shareholder, as well as universal and incalculable benefits be secured to mankind.

The great principles I have endeavoured to illustrate need not be put to the proof by what has been, unhappily, the practical experience we have had of Ocean Telegraphy. If possible, let us forget the past mistakes, so far as they have been committed with pure and unselfish intentions, and follow the simple and unmistakable truths of the sciences involved, without mystifying them with unnecessary complex figures of Euclid, by which we appear to be throwing dust into the eyes of the public. But let us submit implicitly to the master hand of common sense, without which both arts and sciences become—like a sword in the hand of a madman—an intolerable and dangerous nuisance."

"Paris, 11th July, 1863.

From the first railway company that was formed, to the last, the boards of management laboured under no mistake as to the necessity of securing the best available engineering skill. The hills and valleys to be crossed required tunnels and bridges, and the level plain its nicely arranged gradients, and it was for the board to husband and economise the company's capital, by watching the skill and consistency of their engineering arrangements and appliances; and though engineering blunders may have been from time to time made, we admit on the whole, railway engineering has been a great success, so great indeed that some men seem to labour under the delusion that an engineer must have the management of whatever kind of skill may be

involved in the enterprise undertaken. To this erroneous impression may be traced the loss of the Atlantic and other deep sea cables, where engineering talent has not only been exclusively employed, but the nautical studies of the work ignored with seeming contempt for the bare idea of admitting nautical service into the engineer's department. To so great a pitch was this fatal prejudice carried, that eminent nautical gentlemen found it was as good as their reputation was worth to question the propriety of what engineers were doing in matters of Ocean Telegraphy; and whenever any other course of proceeding as to laying cables was suggested, as they often were, to eminent and wealthy men, the prompt response invariably was, "pray who is the engineer? "I could not take part in such an enterprise unless "there is a well known engineer engaged in it." To tell such men there was no need of an engineer—the subject involves only nautical and electrical skill, was found to be a mere waste of words. His mind was made up, and he was assured that engineers were as necessary to the proper laying of Ocean cables as they were to make rail roads, and beyond this they would not admit of any argument.

On one occasion a concession having been obtained from a neighbouring government, some enterprising gentlemen assembled at the Guildhall Coffee House, with intention of forming a company for adopting the concession, which there can be no doubt would have been done, but they unhappily considered it was

utterly out of their power to move without the counsel of an engineer; accordingly one of the most popular of them was invited to the meeting, with whose notions—whatever they were—some of the party had been, or professed to be much enlightened, and others, impressed by the loss of the Atlantic cable, perhaps, dared to presume there might be some mistake about the engineer's very plausible assumptions. There was even then in 1858 a lurking notion that to lay cables in deep water was an operation that belonged more to the seaman than the engineer, who could not practically comprehend the perplexing and surging motion of the ship—in order to command or control the operation; and the dangers a person can neither practically comprehend nor control, he cannot be expected to provide against.

A faint light had indeed come over the minds of some of this meeting, but it was only for the engineer to open his professional lips, to persuade the majority how utterly dark was their light.

The question of laying telegraph cables in the ocean to be sure did not involve tunnelling, bridging, or levelling, not even poles were needed for the wire to rest upon,—but still there was a vague inexplicable something about the subject, which to their minds came exclusively within the range of a civil engineer's profession.

It would have been infinitely more consistent if they had in all seriousness exclaimed with the renowned Lord Dundreary, "there was something about the "subject that no feller could understand."

But let us for a moment leave the ridiculous and look after the sublime shades of the picture, by taking a mere glance at the consequences involved in this blind leading of, and implicitly following, the engineers.

These gentlemen had in their possession, a concession, which, with some alterations that might at the right moment have been obtained, was of great value.

It must not be here omitted that a light and suitable cable was at this meeting pressed on the special notice of the engineer, the merits of which he politely declined to examine,—and it is not too much to add, to the utter destruction of this valuable concession; he seemed to shut his own eyes to the most palpable facts of the case before him, and unwittingly threw dust in the eyes of those who had sought his counsel. He believed, or affected to believe in the suitability of such cables as that which had been lost, but to which the public demurred; therefore from the moment that meeting separated, the concession was valueless and even worse, because it was, at considerable expense to its possessors, kept helplessly to the full effluxion of its time, blocking the way of both public convenience and advancement in the science, to the great annoyance also of the government who had so liberally granted it.

The fault of its loss then most unquestionably rests on him who had undertaken to counsel, and those of the meeting who were so blindly carried away by it, to conclusions so utterly void of the clearest and most

unmistakable principles of science. If they had been sitting over some engineering question of importance, and had called in the advice of a sailor or a surgeon to guide them, they could not have done greater violence to the best rules of social life, for which they all, no doubt, professed a most religious regard. Thus, by gross blundering, what should have been a valuable concession, was utterly lost.

With this, however, we have nothing to do. A mere disagreement between parties was not a permanent bar to the great interests of Ocean Telegraphy. We should not, however, do justice to the cause if we treated so lightly the engineer's position in the transaction; for so long as he continues to assume the functions that so unquestionably belong to another profession, and so long as he continues to exercise or practise the intrusion, he will be a serious obstruction to the progress of this science.

Public opinion, to which all our prejudices must bow, will in time correct the dangerous error into which several great companies have fallen, if their consequent losses have not already taught them wisdom.

Whilst fully admitting the invaluable importance of the practical skill of engineers in the departments to which it is specially applicable, it must be, on the other hand, in the highest degree dangerous, for engineering skill, however practical and ingenious, to take the place of practical seamanship.

It will, perhaps, be said in behalf of engineers,

that if great companies elect boards of management, who in their united wisdom call in advisers, it is not for those who are so honoured to refuse the handsome fees by which they are remunerated.

The law, however, is not considered to be strained when a poor unhappy druggist is heavily fined and imprisoned for having dared to perform some surgical operation or administered medicine unskilfully.

Nor do we exhibit much sympathy for an unfortunate captain, even in the discharge of his arduous duty, when to some thoughtless moment may be attributed the loss of his ship, for which he is disrated, disgraced, or imprisoned. And why should not the same law be made to apply to the engineer who, like the druggist, travels out of his legitimate line, and undertakes to perform what he is professionally ignorant of, and thereby causes loss and damage to his employer. The law makes no allowance for being urgently called in by ignorant people, but attaches blame to the pretender, and justly punishes him.

If this principle held good in Ocean Telegraphy, and the engineers, who may have unwarrantably undertaken to lay cables in the ocean, were held responsible for the losses they may thus be said to have caused, some millions sterling might be laid to their charge, and the deserved punishment would be serious.

By their own mode of reasoning all this has been put down—most unjustly—to the dangers always inseparable from the development of science.

But how is it possible for science to be properly developed if druggists presume to perform the critical duties of a surgeon or physician, or the engineer the most difficult duties of a practical seaman? It is clear, then, that this is only a clumsy attempt to escape the responsibility that in one shape or other, unquestionably belongs to the mistake.

During the last six years the cause of Ocean Telegraphy has been under discussion, and the great principles we have above endeavoured to illustrate, have been invariably treated by some interested engineers with a remarkable disregard, but now that a serious change has presented itself in the public mind, the truth is more likely to be listened to, and the nautical element, hitherto excluded, has grown into favour in despite of all opposition. But such has been the engineering influence over one great company, that up to the present moment that board seems to be completely in the dark as to the necessity of nautical skill even on the Board of Direction. One would suppose that all the vacancies which have of late occurred would have been filled up by the most skilful gentlemen of that profession; such appointments would no doubt have inspired hope in the speedy solution of this great electro-nautical problem.

What would engineers say, let us ask, if some sailor had presumed to set himself up as an engineer, and a bridge he built had fallen, and had been the premature grave of some valuable lives? Or, what would architects say, even, if an engineer had presumed to

undertake the duties, and erected a monster building which became a public laughing-stock and disgrace to the profession throughout the world. Such mistakes, we are told, have been made, at enormous cost, and the natural results of one profession presuming to do the work of another, has followed. We have no doubt the engineer will readily say he would not knowingly encroach upon the domain of another profession, especially one so ancient, so arduous, and so honourable, as the nautical. If they have been mistaken, why should they not retrace their steps by honourably owning the error, and so far make amends, at least to science and to their own honour. Any obstinate resistance could only aggravate the injury, when a frank admission of wrong, is not only a graceful retreat, but a lasting honour to those who have inadvertently committed it.

Such we may hope will soon be their language.

"21st July, 1863.

There seems to be a prevailing notion among those who have not the time, or are not accustomed to reflect on matters out of their daily routine avocation, that if engineers are not to devise its character, and lay the Atlantic cable, of what conceivable use can they be to any Ocean Telegraph Board of Directors? Our former observations on this have shown conclusively, that inasmuch as a sailor must have the charge of laying it, it is only fair and reasonable to allow him to determine also the

character of the cable, that it may be such an one as would be the least dangerous to deal with in a storm, for it is the stormy weather it is his main duty to provide against. If the sea were always smooth, engineers might be as good as sailors for the work, and mechanical appliances could be found for laying safely, cables of any extreme weight. But, as all seamen know, and all past experience confirms, *what they have for the past six years affirmed on this subject*, namely, that considering the great depth and often disturbed surface of the ocean, safety must be sought in the character of the cable instead of machinery for restraining, and making abortive attempts to regulate its departure from the ship. But still there is ample room for the engineer to exercise his skill in other departments.

It is, for example, necessary to make the shore ends of the cable secure from the violence of the storm. It may be desirable, and, we may add, the nautical profession would recommend, that all cables should, whenever practicable, be landed on a well-chosen beach, and buried two or three feet under the ground, as far out from the shore as to avoid the effects of the surge; and this limit is not far off shore, where the water is deep. This idea may be *nautical* in its character, but its execution demands the careful skill and attention of an engineer, where the use of the diving bell may be essential.

Again, the interests of a Company may—on a large scale—be indirectly, if not directly, involved with

land lines, from which engineering considerations are inseparable, and the Board of any Ocean Telegraph Company, could not on this account consistently work without its engineering adviser, which we may presume to be a branch of the electrician's department, in which nautical science would be as useless, as the scientific civil engineer would be on board ship in a storm.

It must, on all hands, be admitted that nautical science is essentially different from every other. Though the electrical department might in some respects be identical with that of the engineer, neither of them can possibly be considered as nautical in their character.

How readily, and how justly, would the engineer condemn the sailor who presumed to apply the technical or scientific terms in nautical science to explain a plain truth in his profession? Suppose he spoke of corrections in paralàx and refraction, or index error, in his practical astronomy, when only those of his audience, who happened to be of his own profession, could practically comprehend the terms.

It is true the nice points conveyed by such expressions have much to do with the results of practical astronomy, of which he is supposed to be master. But to import them into observations to persons whose profession or calling did not comprehend such learned details in nautical science, would justly be considered as a means to mystify an audience, and not to edify it.

Happily nautical gentlemen are not accustomed to this display, though the more vulgar, but not less important technicalities of the science are always telling to a maritime people; they are seldom advanced. They are, therefore, the more ready to observe what emanate from amateur sailors. Such gentlemen of another profession, who seem so complacently to labour under the mistake that sailors are ignorant of either arts or sciences, and dare not question whatever may be advanced by any professed mathematician, who has the figures, signs, and rules of Euclid and Algebra at his command.

They seem, unhappily, not to have reflected on the admitted practical advantages of travelling, or they would not encroach upon the line that so clearly marks the nautical profession; to neglect a proper notice of the intrusion, would be a violation of duty to the science, as well as to those distinguished and honorable engineers who have not ventured on the dangerous domain of their neighbours.

If a marine engineer of high repute (and there are many, who have passed a large portion of their lives in the engine room of some of the noble steamers which have crossed the Atlantic so long and so successfully,) had been but consulted about laying cables across the ocean, there might have been some degree of excuse; but this class of engineers, to whom so much honor and credit is due, has never yet appeared on the stage of Ocean Telegraphy. But if their advice had been sought, the answer, no doubt,

would have been:—"I recommend you to consult my captain, who is a thorough and scientific seaman. He shapes the course, orders the amount of steam or revolutions of the engine, and makes the voyage with great regularity, *storms*, *fogs*, and *dark nights notwithstanding*. As his engineer, I am bound to obey him, and do so with pleasure. He will tell you all about the requirements for laying cables across the Atlantic in unmistakable terms."

It may be interesting here for the sake of the cause we are considering, to mark the difference between the engineer's and sailor's method of conveying information to the public on one, at least, of its principal points.

For example, the engineer describes the cable he recommends to be used thus:—

" Specific weight = 1.6 will support 5.6 knots of its own weight in sea water.

" Its breaking weight 32.5 cwt.

" Its elongation when exposed to a strain of

1-5th	breaking weight	= 0.14	per cent. of its length.
1-4th	"	= 0.19	"
1-3rd	"	= 0.33	"
½	"	= 0.62	"
¾	"	= 1.12	"

And shortly before breaking = 1.5.

" The outer covering of this description for a core of half an inch diameter can be manufactured at the price of £ per nautical mile."

This may be intelligible to engineers, but conveys

no plain reason whatever to the general reader why such cable should be adopted.

Now let us see what sort of description a sailor will give of this cable. He proceeds to examine its weight, both dry and submerged, and finds that in the dry state the mile of 1,760 yards is 1,549¾ lbs. and when submerged, the mile of 1,760 yards weighs 884½ lbs.

It, therefore, follows that in a depth of 2,640 fathoms, the weight of this cable simply suspended to itself would be about 2,652 lbs.

And as some hundreds of miles across the Atlantic is supposed to be about the three miles depth above indicated, this enormous weight might any moment come upon it, and would inevitably be its destruction. Therefore the public can come to the conclusion that such cable, at least, cannot, with reason, be adopted, however learned may be the figures of the engineer.

There are other and equally grave objections to such cable. The least tension that comes upon it must bear directly upon the electric wire, which, of all things, must be avoided.

Then comes the difficulties of splicing, coiling, and paying it out, which are all alike practically most dangerous operations, if not fatal objections to the use of such cable, even if its specific gravity was suitable.

Our object is to discover the most practicable cable, regardless of parties or interests; hence the necessity of discussing the question on its merits; admitting the possibility of the greatest stranger to any branch of science hitting upon the identical cable required,

however conclusive may be the fact that a seaman, and only a seaman, can be entrusted with the charge of laying it across the ocean.

We have only in a very faint degree considered the danger of men meddling with what they do not understand.

Take, for example, currents of the ocean. Is it in the nature of the nautical, or engineering profession, to know, practically, their *cause and effect?*

The indisputable answer will be, the nautical man has both the cause and effects of currents associated inseparably from his daily avocation, whilst the engineer has only some vague theoretical notion that "currents are a very critical and dangerous element in the engineering problem of Ocean Telegraphy," and by drawing some geometrical curves, and displaying some abstruse calculations, that to the uninitiated seem very learned, and probably, to him, very convincing that none but the most talented engineers could possibly solve this mysterious department of the problem.

I am not disposed to rake up bygone transactions only so far as the cause of truth in science requires it, but we could quote the words of a report made by the engineer in charge of a cable, several hundred miles of which were lost partly from evident ignorance of this portion of the duties he had undertaken.

This engineer has told the world in his report that "the current was carrying the cable away at an angle from the direct course of the ship, so fast"—nearly

three miles an hour—"that he was obliged to apply one increasing degree of restraint after another, until at last the cable broke." At this period of the operation, the cable was running out at the rate of nearly six miles per hour, whilst the ship was only going three miles over the ground, thus wasting nearly one half of the cable.

Now the public will admit that if this "accident," as it has been considerately termed, arose from ignorance, it is rather too costly, and, in other respects, far too important to remain longer unexplained.

It may be reasonably asked, how do we prove the loss of cable referred to, arose from ignorance? and we use the term in no offensive sense, but to show that those outside the nautical profession would be practically ignorant of the work in hand.

The answer will be found in the practical philosophy of our best nautical men:—

First. In that part of the Atlantic where this cable was lost, all navigators will agree there never did exist a current such as the engineer has imagined.

Second. If any current at all—which is doubtful—it was on the surface, and could not carry away the cable as he described, because it instantly sunk below the effects of the current.

Thirdly. Currents are always and exclusively on the surface, and if its depth were so great as to carry the ship away from the cable, the reason would have been natural, but the engineer did not so report it.

There are no such things as "rivers in the ocean;" the vast evaporation from the ocean is perpetual, and the same perpetual return of the water keeps up the ocean level by naturally spreading over the surface from whence it came—but this is never so strong in the ocean—beyond the influence of great rivers—as to carry a ship at any appreciable speed.

It is, in fact, clear to all practical seamen who have studied the subject, that neither the ship nor cable was at all disturbed by current. But another clear and unmistakable cause existed,—one that if the engineer was not totally ignorant of, he adopted no precautions to guard against it, but ignored its very existence in his report, though it was the real and indisputable cause of the loss of that cable, and, we may add, of several others since:

Namely, the ponderous specific gravity, or weight of the cable in water, which, on reaching the deep sea, caused it to dash from the ship, bidding defiance to the least control.

So little did the engineer seem to comprehend the task he had undertaken, that the specific gravity of his cable was never supposed to be a matter worthy of contemplation; and when, to his surprise and consternation, the fatal consequences presented themselves, as he entered upon deep water, *instead of increasing* the speed of the ship, which would naturally give the cable a more horizontal position, and so reduce the speed at which it would sink, he, in a state of evident alarm, reduced the speed of the

ship, thereby allowing the cable to take a more vertical direction, which, consequently, increased alike the speed, the danger, in a word, the impossibility of controlling its increased momentum.

In justice to these remarks, we must say this danger was clearly pointed out to the Chairman, Deputy Chairman, and some of the Directors under whom the engineer was employed, long before any attempt was made to lay the cable, and *nautical gentlemen entreated them to pause and reflect before attempting to lay it;* and ever since then the dangerous character of metal cables for ocean purposes we have not ceased to press upon their attention.

It is now over six years since the loss of that cable, and the error to which the loss must be attributed; which has been unmistakably ascertained, yet to this hour neither the error, or its plan of correction, has been frankly and publicly admitted, though the most searching inquiry, under control of the Government, is supposed by most people to have been complete.

The public, however, is entitled to some explanation of this unfortunate affair, which can be summed up in a few words. The inquiry which was made by this commission was conducted entirely as if the question of Ocean Telegraphy was shrouded in some engineering difficulty, and the solution of some complex problem in that branch of science was involved, and so exclusively was this course pursued, that the nautical profession, we repeat, was not even represented on the commission. The report of this inquiry,

therefore, is signed by none but landsmen, and cannot embrace the nautical science, though the matter under inquiry was essentially in its most important features, nautical in its character.

If this had been a private inquiry, we should have no right to complain; but being under the special protection of the Board of Trade, both Europe and America looked forward with the deepest interest to the report of this commission as a final and complete solution of the problem. Assured that the philosophy of the ocean would have been sifted to its utmost limit, that every conceivable description of cable would have been by a master hand examined by the stern requirements of that philosophy, and the world left no longer in doubt, as to the real character of the work or the laws by which it must be done.

Unhappily this was not the result of that prolonged inquiry, for neither the philosophy of the ocean, nor the branch of science most specially involved in the problem were put under examination at all. The truth is—and the engineer will benefit by the truth being told—a committee of engineers endeavoured to square every difficulty in the case with their own profession, which was found to be impracticable, and so the subject is left where they found it; and the country, or at least the Atlantic Company, are even now like a ship without a rudder, floundering about with no defined notions of the science or its philosophy, or what kind of cable is most suitable to run across the Atlantic.

No better proof could be given of this than the advertisement issued on the 20th of July last by the Atlantic Company, which shows they have arrived at no defined conclusion as to the means by which they will perform their task, or they would simply have described their cable, and invited the world to compete for the perfection of its manufacture and economy in its cost.

Instead of this they have invited manufacturers to send them specimens of cables of their own designs, from which the Company may choose.

The very cost of the specimens will deter compliance with the advertisement. Any prudent and trustworthy manufacturer will naturally say you have surely by this time discovered precisely the kind of cable you require? If not, and you are still without principles of action, how can I tell what fancy or freak may be taken by that board after I have spent £100 or £150 in making such specimen or sample as they ask for, however good it may be they are not bound to take it; after having spent so vast a sum in experiments and taken part in the Local Government Enquiry, you cannot tell what you really want. By what reason could any manufacturer run the risk of pleasing a board who by their advertisement admits that it is guided by no fixed principles, nothing could be clearer than that some favourite manufacturer is contemplated, and the advertisement as clearly intended to make the world, and the shareholders in particular, believe there has

been a fair, honourable, and public competition for producing and making the best cable. Such complete want of candour and sincerity cannot be productive of the desired results.

Bridges in a thousand different forms may be used and made of stone, or iron, or wood; the engineer produces his specification, which is invariably published when tenders for its construction are invited. But though neither wood, stone, nor iron can rightly form any part in the construction of ocean telegraph cables, there can be no reason why a Board of Management cannot arrive at a clearly defined specification on which a contractor could make his estimate. The board could, with indisputable reason, give a name to the material required, at least they could say, that iron has, against light and reason, been tried, and signally failed. Contrary to all the known laws of nature, iron has been mixed with hemp and tried; a most miserable failure has been the result of this attempt.

To what then can we turn to secure consistency with the unalterable laws of nature that will make the best ocean telegraph cable—will hide, wool, silk, or hair, serve the purpose? If an available quantity admitted the use of these, their cost would render any one of them impracticable.

Why not own then at once, the material that is by nature best calculated to serve the purpose, and no doubt designed by providence to accomplish the object without difficulty, is to be found in the fibrous

substances so abundantly at our hand. Hemp, flax, cotton, coir and the various grass, and barks, none of which are beyond reach as to price or quantity, surely a selection could be made from this limited circle of materials, leaving only the mode of manufacture to be determined, and this could no doubt be readily settled to the satisfaction of the professors in nautical and electrical science. If not, we have only to wait for the more perfect development of the use of these materials, and not confuse and perplex the subject by leading the world to suppose no step whatever has been made in the work, by issuing advertisements with the object of misleading the public, or what is still more dangerous to the cause, to favour special manfacturers at the cost of the company pecuniarly, and of the public morally.

In conclusion, I must add, it is due to my own sense of justice to the cause, as well as to the respect I entertain for professional gentlemen, to assure those of the engineering class who may feel my remarks to apply severely to them, that however unfortunately administered, I am willing to admit their labours have been most sincere in their character.

In the early stages of the new science of Ocean Telegraphy — in contra-distinction to that of shallow water, it was not for engineers to perceive where the nautical science was essentially required. Therefore, whilst I tender to them the most ample apology for any seeming severity of remarks in this or any previous statement I have

considered it my duty to make on this subject, they will, I trust, at the same time, admit its vast importance demanded that a severe line of demarcation should be drawn, and that neither mistake or doubt should be allowed to exist as to what branch of science the duties involved in this new enterprise belonged.

If I have been unable to clear away some mistaken and dangerous notions on the subject of Ocean Telegraphy, I am sure they will not hesitate to sustain the high and noble character of their profession, but frankly and honourably admit the errors, and for the sake of the best interests of science cordially concur in their correction.

It is in this spirit of inquiry after truth, and to its honourable and impartial application that any great work of imperial character can be made secure and durable.

If a great national work, therefore, involves the combined applications of several branches of science, it is the duty of each to unite their best efforts to accomplish it, and so do what little they can, to honour the great author and giver of all the sciences, whilst as instruments we fulfil his design by applying them to the use and happiness of man.

The reader will readily perceive from the brief and imperfect remarks we have offered, that each department of this vast subject could not be adequately discussed in the limited form of a pamphlet.

Much remains to be said, and more particularly on insulating the electric conductor — the nature and effects of currents and tides in their different characters — and above all the means we employ for preserving the hempen cable, both when submerged and during its transit from the place of manufacture. This is the more important, because it applies to every description of fibrous substances, and for all purposes, more especially to the anti-fouling of iron ships' bottoms, as well as to the preservation of the cable. All these branches of the subject are of the greatest importance, we may therefore discuss them with advantage in another edition of the pamphlet.

OPINIONS.

Since the publication of my pamphlet on "The New Submarine Telegraph Cable," and the public exposition of the Preserved Hempen Telegraph Cable in June, 1858, the following are some of the opinions that have appeared in the metropolitan newspapers and other publications:—

The Times, September 30, 1858.

"Among those who have come forward with remedies for overcoming the difficulties of the Atlantic, in case a new rope is required, is Mr. Rowett, who, that there may be no mistake about the matter, expresses himself willing to contract to lay a rope from Valentia to Newfoundland for as small a sum as £182,000. Mr. Rowett's plan is simply that of a rope-covered electric wire, instead of the old mode of proceeding by wire-covered rope. Mr. Rowett's idea is to have the conductor well and safely insulated, and then simply enclosed in strands of a common

hemp cable, about an inch in diameter, well preserved. A piece has already been made; this specimen is certainly as light, as flexible, and as strong as could be desired, and these qualities must be the very *sine qua non* with all future Atlantic telegraphs. * * * All the experiments in very deep seas tend to show that the principle of a rope-covered wire is the right one after all. For any depth under 1,000 fathoms, a wire rope is the best and cheapest; for great depths, 2,000 and 3,000 fathoms, it becomes the dearest, because the worst and most difficult to submerge. No man who has ever seen a deep sea-wire laid, but must have been convinced that covering the rope with wire was only making a difficulty which required all the costly apparatus of paying-out machinery, breaks, and check tackle to contend against, and which, in but too many instances, it has been impossible totally to overcome. A rope-covered wire, light enough to be very cheap, and, because light, therefore strong, with such a coil running from a steamer going ten miles or so an hour, a dozen cables might be laid across the Atlantic in a twelvemonth, if no other difficulties exist."

The Morning Post, September 20, 1858.

"A great variety of causes have been assigned for the failure of the Atlantic cable, but none of the newspaper communications intimate the least imperfection in the character of the cable itself. This

remarkable omission has been evident throughout the preparation both of the cable and of the apparatus for submerging it, as if the construction of the former was perfect, and all that was required was the best means of laying it down. A doubt may now be fairly raised whether the reverse is not the fact, and whether the difficulty is not in the construction of the cable, for if that had been judiciously selected, there would have been no need for engineers, or of a complication of machinery to lay it. * * * A number of scientific gentlemen assembled on Saturday, at Leadenhall Street, for the purpose of witnessing some experiments with a new description of cable, invented by Mr. W. Rowett. This gentleman views the subject in the light of a sailor, and not of an engineer—disclaims the theory of ocean currents at great depths, and denies altogether the truth of the prevailing notion that the density of water at increased depths is so great that objects, however heavy, never reach the bottom of the ocean. Mr. Rowett contends that currents have but little to do with laying telegraph cables, * * * and from the shrinking quality of the fibre, which is produced by submersion in water, it is, therefore, peculiarly adapted to the work of protecting the electric wire. Whether the fibre cable will, in practice, be found to answer its object remains to be seen; but its great simplicity and inexpensive construction give it claims to the attentive consideration of all interested in the progress of telegraphic science."

The Press, August 28, 1858.

"We are bound to form our judgment by what is placed before us and before the world, regardless of every individual interest; and, after deliberately examining the semi-floating cable proposed by Mr. Rowett, preserved as we find it would be, according to the remarkable tests to which it has been subjected, and which we have taken pains to examine, we should be doing violence to our convictions if we did not say it deserves the especial attention of those who may have the direction of Ocean Telegraphy, which is now elevated to the highest national importance."

The Press, September 11, 1858,

After forcible allusion to the Atlantic and other objectionable cables made of iron, said:—

"These difficulties were ably pointed out by a pamphlet on Submarine Telegraphs, by Mr. Rowett, to which we have already called attention in a previous number, and the results of the late experiments seem to have fully justified the apprehensions entertained."

The Daily Telegraph, September 20, 1858.

"On Saturday last, we were present at an inspection of a new Ocean Telegraph cable, invented by Mr. W. Rowett, of Leadenhall Street, and which has

been offered to the Atlantic Company, for laying between Valentia and Newfoundland. * * * The rule is that no strain should be allowed to bear upon the electric wire or the gutta-percha. Mr. Rowett contends that the cable should be of as simple and light a character as possible. * * * The ease with which the cable could be paid out is undoubted, and another advantage is, that it will bear a tension of about four tons, and not half of its strength is required in raising for the purpose of repairs. * * Altogether we may say the invention is one which reflects credit on the mind which conceived it, and from its simple and common sense character, we hope to see it successful in connecting nations now separated by vast oceanic expanses."

NOTE.—The opinion of the late Mr. Robert Stephenson as to deep sea cables will be found in a note addressed to Sir Stafford Northcote, dated 25th May, 1859, which appears in the Blue Book of 1859 (page 161), in which he distinctly disapproves of such cables as that made for the Gibraltar line for deep sea purposes, and recommends "*a simple hemp covering*."

Maury's Physical Geography of the Sea. Eighth Edition, published in 1860, page 21.

" Our researches at sea have shown that there is no running water at the bottom of the deep sea.

Hence we infer that a telegraphic cord once laid on the bottom of the ocean, there, as the tree that falls in the forest, it would lie, for there is nothing to disturb it more.

The iron wrappings for deep sea lines are an incumbrance and a waste."

Maury, Eighth Edition, page 331.

"It has been ascertained that the bed of the ocean is lined with the microscopic remains of its own dead, with marine feculences which lie on the bottom as lightly as gossamer."

Page 332.

"Currents reside at and near the surface. * * * The greatest depth at which running water is to be found in the sea is probably in the narrowest part of the Florida pass."

Dr. Henry Conneau, the eminent first physician of His Imperial Majesty Napoleon III., published an eloquent address in 1861, in support of Rowett's system of Ocean Telegraphy, which commences with the following remarks: — "The first indispensable condition requisite to assure success to any Submarine Telegraph Cable is perfect insulation and flexibility. Without the first requisite named, perfect transmission of electric signals is impossible; without the second, no cable can be successfully laid at the sea bottom. This being the case, it is

absolutely essential that the electric conductor should be protected by a covering composed of some substance which shall be *a good non-conductor*, and at the same time be flexible and elastic, and of a specific gravity sufficient to permit the cable to descend properly to the bottom."

The learned Doctor quotes the following passage from *Maury's Physical Geography of the Sea*, Third Edition, page 345:—"'The first step towards success in the establishment of submarine lines of telegraph across oceans, is to get rid of the idea of iron ropes and great cables for the deep sea—limit these to shallow waters only—to divert ingenuity from brakes and buoys, and to direct it to *cord that will require neither.*' There is both truth and force in this opinion."

"A submarine telegraph line," he says, "free from interruption in the electric currents, I believe to be as practicable across the Atlantic or the Pacific as across the Alps or the Andes. The true question to be considered * * is not how wide or how deep the sea may be, nor how far the influence of storms may affect the sea's surface, but what are the electrical limits to the length of submarine lines. I have no doubt whatever of the success of a telegraph across the Atlantic. The sea offers no obstructions on account of its depths or its currents to lines of any length.

"Let me add, in conclusion, my sincere approval of the sentiments advanced by Lieut. Maury." (p. 347.)

THE "COSMOS,"

"Paris, 1st February, 1861.

(From an article bearing the signature of L'ABBE MOIGNO.)

Mr. Rowett, of whom the *Cosmos* has before spoken, * * in place of the iron covering, has substituted simply one of hemp. * * * * * At the bottom of the deepest sea, Mr. Rowett's cable retains its volume, its exact form, and its conducting power. * * * * We have, then, the right of drawing this conclusion, that the cable of Mr. Rowett absolutely leaves nothing to be wished for, that it may be laid without difficulty. * * * We are now in possession of a project for a line, a project for a cable, and a project for transatlantic communication, of which the success is in our eyes as certain as if we already beheld it realised before our eyes. It is, then, because the marine cable of Mr. Rowett's invention is a great fact that it is to be laid between Brest and St. Pierre Miquelon. It ought to be borne in mind that this serious enterprise has been taken under the protection of the French Government, under liberal legislatiff guarantees.

Report of the Commission appointed by the Government, published April, 1861 (page xxvi.), we read thus:—

' Wire, however small, will break with its own

weight at a length of about three miles, and an iron rod, however large, also breaks at the same length, the strength being, of course, in proportion to the area, and, therefore, in proportion to the weight. In dealing, therefore, with deep sea cables, it is evident that the strain cannot be varied by a change in the size of the cable itself, *but by* the alteration of the specific gravity of the substance employed. The specific gravity of hemp is little greater than that of water, and, consequently, no strain occurs with hempen cables whatever be their length."

Page xxxv.

"In any case the outer covering should be so devisd as to prevent a strain coming on the core, and the specific gravity should be adapted to the depth, and be such as to ensure the cable sinking evenly."

Nothing but a hemp cable could meet these requirements it is clear and obvious. Such opinions as the above could be multiplied to any length, but these amply justify immediate action in the enterprise.

APPENDIX.

"The Great Northern Railway, Stores Department,

"King's Cross, London, August 2nd, 1862.

"Dear Sir,—Some time ago I tested Captain Rowett's prepared cloth by burying it in decomposed vegetable and animal matter, together with portions of the same material unprepared, and on examining the same three weeks after, I found the prepared material sound and as good as new, the unprepared material entirely destroyed.

"I am dear Sir,
"Yours truly,
(Signed) "WILLIAM PULFORD."

"T. E. WELLER, Esq."

"London, 2nd, December 1862.

"W. Rowett, Esq., Dear Sir,—I beg to send you a certificate of your solution from the chief store keeper of the Great Northern Railway, and have the pleasure to inform you that he intends using it for their canvas waggon covers.

"On the 26th of October, Messrs. James Brothers and I buried two pieces of canvas torn asunder, one saturated with your solution, and the other in its natural state in a damp part of the adjoining church yard. December 1st, (yesterday) we dug it up, and the result was just the same as Mr. Pulford's,—the prepared piece was as strong as ever, while the unprepared

piece was completely rotten!—to the great astonishment of Messrs. James, who intend to make use of it for their corn sacks.

"In this experiment the canvas was allowed to remain in the ground nearly double the time Mr. Pulford's was buried,—this we did in order to test more strongly the enduring power of your solution.

"I remain Sir,

"Very truly yours,

(Signed) "T. E. WELLER."

"Paris, 19th of May, 1859.

"The undersigned having been present this day in the garden of the residence of Monsieur Lavallard, 27, Rue de la Pépiniere, where several pieces of canvas and linen yarn were removed from the ground, where they had been buried together on the 28th of April last in the presence of the undersigned F. Brunet, and Charles Miette,—part of the said articles being prepared with Mr. Rowett's solution for preserving fibrous and other substances, and another part of the said articles being in their simple and original manufactured state.

"We hereby declare, that on examining the said articles, we found those that had not been prepared were completely decomposed, and totally unfit for any kind of use, whilst the other articles above described, which had been prepared with Mr. Rowett's solution, were perfectly sound, and were not in the least degree affected by the severe corrupting influences to which they had been exposed.

(Signed)
Chs. Miette.
F. Brunette.
Pr. Cohen, & Co.
W. Sutton.
Servaas de Jong.
F. Spiers.
Gurt. Ourgis."

APPENDIX.

"H. M. Dock Yard, Portsmouth, May 24th, 1864.

"My Dear Sir,—I am glad to inform you that the piece of hemp rope dipped in your Preserving and Anti-fouling Solution was taken up yesterday with ten other specimens of hemp and rope prepared with other means, and all of which had been under water for twelve months in the foulest place in the harbour, and your specimen is reported by the officers as a most perfect result, showing no signs of deterioration or decay, of loss of strength, or the slightest fouling.

"Nothing can be more conclusive than this trial has been, and I congratulate you on the result.

"Yours very truly,

(Signed) "GEORGE ELLIOT."

"To Captain Rowett."

Report on experiments with Hemp and Wood, made by the verbal directions of the Admiral Superintendent.

Put down, May 2nd, 1863.	Taken up and examined, May 27th, 1864.
Some rope $2\frac{1}{2}$in. circumference, prepared by Mr. Rowett. A piece of wood also prepared by Mr. Rowett.	Both wood and rope very perfect and quite clean from Barnacles, Weed, or Polypi. The rope appeared uninjured and strong as when first immersed.
Some unprepared rope and wood.	Both rope and wood completely penetrated by the worm, and much decayed.

(Signed) H. Cradock, Master Shipwright,
30th May, 1864.

(Signed) Wm. John Hay, Chemical Assistant,
30th May, 1864.

Copied from the Report made to the Admiralty.

There have been numerous proofs of this kind, of the preserving character of the Solution, which beyond all question proves its most enduring and therefore valuable character.